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IL&FS | Environment

TECHNICAL EIA GUIDANCE MANUAL
FOR
COMMON MUNICIPAL SOLID WASTE MANAGEMENT FACILITIES

Prepared for

The Ministry of Environment and Forests
Government of India





by

IL&FS Ecosmart Limited
Hyderabad

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ACRONYMS

AAQ	Ambient Air Quality
BOD	Biological Oxygen Demand
BOQ	Bill of Quantities
BOT	Build Operate Transfer
CCA	Conventional Cost Accounting
CDM	Clean Development Mechanism
CER	Corporate Environmental Reports
CEAA	Canadian Environmental Assessment Agency
CFE	Consent for Establishment
CMSWMF	Common Municipal Solid Waste Management Facility
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organization
CREP	Corporate Responsibility for Environmental Protection
CRZ	Coastal Regulatory Zone
DA	Development Authorities
DMP	Disaster Management Plan
EAC	Expert Appraisal Committee
ECI	Environmental Condition Indicators
EcE	Economic-cum-Environmental
EIA	Environmental Impact Assessment
EIS	Environmental Information System
EMA	Environmental Management Accounting
EMP	Environmental Management Plan
EMS	Environmental Management System
EPI	Environmental Performance Indicators
EPR	Extended Producers Responsibilities

EPZ	Export Processing Zones
ES	Environmental Statements
FCA	Full Cost Assessment
FCO	Fertilizer Control Order
GHG	Green House Gases
HAZOP	Hazard and Operability Studies
HTL	High Tide Level
IC	Internal Combustion
IL&FS	Infrastructure Leasing and Financial Services
ISO	International Standard Organization
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
LCA	Life Cycle Assessment
LDAR	Leak Detection and Repair
LTL	Low Tide Level
MCA	Maximum Credible Accident
MoEF	Ministry of Environment & Forests
MoUD	Ministry of Urban Development
MSW	Municipal Solid Waste
NAQM	National Air Quality Monitoring
NEERI	National Environmental Engineering Research Institute
NGO	Non-Government Organizations
O&M	Operation and Maintenance
PM	Particulate Matter
PPA	Participatory Poverty Assessment
PRA	Participatory Rural Appraisal
QA/QC	Quality Assurance/Quality Control
QRA	Quantitative Risk Assessment
RDF	Refuse Derived Fuel
RWA	Residents Welfare Association
SEA	Strategic Environmental Assessment
SEAC	State Level Expert Appraisal Committee
SEIAA	State Level Environment Impact Assessment Authority
SEZ	Special Economic Zone
SIA	Social Impact Assessment
SPCB	State Pollution Control Board
SPM	Suspended Particulate Matter
TCA	Total Cost Assessment
TCLP	Toxicity Characteristic Leaching Procedure

TEQM	Total Environmental Quality Movement
TGM	Technical EIA Guidance Manual
ToR	Terms of Reference
ULBs	Urban Local Bodies
UT	Union Territory
UTEIAA	Union Territory Level Environment Impact Assessment Authority
UTPCC	Union Territory Pollution Control Committee

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Acknowledgement

The Notification issued on the prior environmental clearance process by the Ministry of Environment and Forests (MoEF) on September 14, 2006 delegated substantial powers to the State Level Environment Impact Assessment Authorities (SEIAA) to grant environmental clearance for certain categories of developmental activities/projects. It was felt that proper guidance to the stakeholders would enhance appreciation of environmental impacts of proposed projects and possible mitigation measures. Further, such a guidance would also help ensure that decision making authorities across different States and Union Territories could adopt similar considerations and norms with due weightage for site-specific considerations.

We feel privileged to be part of the interventions being spearheaded by Sh. Jairam Ramesh, Hon'ble Minister, MoEF, Government of India, to mainstream environmental considerations in the decision making process. IL&FS Ecosmart as part of this important initiative, prepared Technical EIA Guidance Manuals for 27 identified development activities. In view of the diversity of 27 developmental activities entrusted to IL&FS Ecosmart Ltd., in consultation with the MoEF, an expert Peer and Core Committee was constituted to review and finalize each of the draft Manuals. The Manuals prepared by IL&FS were technically reviewed and up-dated by the respective sector-specific expert resource persons.

The Manuals designed by the Expert Committee have benefitted from the advise and feedback received from MoEF. The Manuals are designed to provide readers with an in-depth understanding of the environmental clearance mechanism, developmental activity specific environmental impacts with possible mitigation measures, environmentally compliant manufacturing/ production processes and pollution control technologies, etc.

IL&FS Ecosmart hopes that these Manuals are a step forward to realize the MoEF's desired objective of enhancing functional efficiency and effectiveness in the environmental clearance process. We hope the stakeholders will find the Manuals useful.

We take this opportunity to convey our appreciation to the MoEF team under the leadership of Mr. J.M. Mauskar, Additional Secretary, for the technical inputs, guidance and support extended throughout the project period for successful completion of the project. The technical guidance and support extended by the Expert Peer and Core Committee under the Chairmanship of Dr. V. Rajagopalan, former Chairman, Central Pollution Control Board and inputs of the sector-specific resource persons are gratefully acknowledged.

(Mahesh Babu)

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FOREWORD

The Ministry of Environment & Forests (MOEF) introduced the Environmental Impact Assessment (EIA) Notification 2006 on 14th September 2006, which not only reengineered the entire environment clearance (EC) process specified under the EIA Notification 1994, but also introduced a number of new developmental sectors which would require prior environmental clearance. The EIA Notification 2006 has notified a list of 39 developmental sectors which have been further categorised as A or B based on their capacity and likely environmental impacts. Category B projects have been further categorised as B1 and B2. The EIA Notification 2006 has further introduced a system of screening, scoping and appraisal and for the setting up of Environment Impact Assessment Authority (EIAA) at the Central level and State Level Environment Impact Assessment Authorities (SEIAAs) to grant environmental clearances at the Central and State level respectively. The Ministry of Environment & Forests is the Environment Impact Assessment Authority at the Central level and 25 State Level Environment Impact Assessment Authorities (SEIAAS) have been set up in the various States/UTs. The EIA Notification 2006 also stipulates the constitution of a multi-disciplinary Expert Appraisal Committee (EAC) at the Centre and State level Expert Appraisal Committees (SEACs) at State/UT Level for appraisal of Category A or B projects respectively and to recommend grant/rejection of environmental clearance to each project/activities falling under the various sectors to the EIAA/SEIAAs respectively.

Although the process of obtaining environmental clearance consisting of Screening, Scoping and Appraisal and for undertaking public consultation including the process of conduct of Public Hearing has been elaborated under the EIA Notification 2006, the Notification itself provides for bringing out guidelines from time to time on the EIA Notification 2006 and the EC process with a view to bringing clarity on the EC process for expediting environmental clearance. This need was further reinforced after the constitution of SEIAAs and SEACs in various States, who were assigned the task for the first time and for addressing the concerns of standardization of the quality of appraisal and in reducing inconsistencies between SEACs/SEIAAs in granting ECs for similar projects in different States.

The Technical Guidance Manual of **"Common Municipal Solid Waste Management Facilities"** sector describes types of EIA, process and pollution control technologies, operational aspects of EIA with model TOR of that Sector, technological options with cleaner production,

monitoring of environmental quality, post clearance monitoring protocol, related regulations, and procedure of obtaining EC.

Challenges and deficiencies in the municipal solid waste system in India include partial segregation of recyclable waste and no system of primary waste collection at doorstep. However, there are suggested practices to both minimize the environmental impacts of landfills and to move towards good combustion practices by way of incineration technology. Although, the conventional technologies are being improved continuously, but major thrust should be given for improvement of unconventional technologies which promises use of renewable source of energy and are environmental friendly. To improve these technologies, industry and educational institutions should join hands for the brighter future. India's industrial competitiveness and environmental future depends on Industries such as Common Municipal Solid Waste Management Facilities adopting energy and resource efficient technologies. Recycling and reuse of materials is critical.

To keep pace with changing technologies and needs of sustainable development, the manual would require regular updating in the future. The manual will be available on the MoEF website and we would appreciate receiving responses from stakeholders for further improvements.

I congratulate the entire team of IL&FS Ecosmart Ltd., experts from the sector who were involved in the preparation of the Manuals, Chairman and members of the Core and Peer Committees of various sectors and various Resource Persons whose inputs were indeed valuable in the preparation and finalization of the Manuals.

(Jairam Ramesh)

1. INTRODUCTION TO THE TECHNICAL EIA GUIDANCE MANUALS PROJECT

Environmental Impact Assessment (EIA) is a process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant impacts of development proposals prior to major decisions being taken and commitments made. These studies integrate the environmental concerns of developmental activities into the processes of decision-making.

EIA has emerged as one of the successful policy innovations of the 20th Century in the process of ensuring sustained development. Today, EIA is formalized as a regulatory tool in more than 100 countries for effective integration of environmental concerns in the economic development process. The EIA process in India was made mandatory and was also given a legislative status through a Notification issued by the Ministry of Environment and Forests (MoEF) in January 1994. The Notification, however, covered only a few selected industrial developmental activities. While there are subsequent amendments, the Notification issued on September 14, 2006 supersedes all the earlier Notifications, and has brought out structural changes in the clearance mechanism.

The basic tenets of this EIA Notification could be summarized into the following:

- Pollution potential as the basis for prior environmental clearance instead of investment criteria; and
- Decentralization of clearing powers to the State/Union Territory (UT) level Authorities for certain developmental activities to make the prior environmental clearance process quicker, transparent and effective.

Devolution of the power to grant clearances at the state level for certain category of the developmental activities / projects is a step forward to fulfill the basic tenets of the re-engineering *i.e.*, quicker, transparent and effective process but many issues impede/hinder its functional efficiency. These issues could be in technical and operational domains as listed below:

Technical issues

- Ensuring level playing ground to avoid arbitrariness in the decision-making process
- Classification of projects which do not require public hearing and detailed EIA (Category B2)
- Variations in drawing Terms of Reference (ToR) of EIA studies for a given developmental activity across the States/UTs
- Varying developmental-activity-specific expertise requirement for conducting EIA studies and their appraisal
- Availability of adequate sectoral experts, particularly within regulatory agencies and both the Central and the State/Union Territory level and variations in competency levels, leading to the requirement of setting up expert panels consisting of sectoral experts from other agencies/organizations.

- Inadequate data, data verification, cross checking tools and supporting institutional framework
- Meeting time targets without compromising with the quality of assessments/ reviews
- Varying knowledge and skill levels of regulators, consultants and experts
- Newly added developmental activities for prior environmental clearance, *etc*.

Operational issues

- State level /UT level EIA Authorities (SEIAA/UTEIAA) are formulated for the first time and many are functioning
- Varying roles and responsibilities of involved organizations
- Varying supporting institutional strengths across the States/UTs
- Varying manpower availability (in terms of expertise and experience), *etc*.

1.1 Purpose

The purpose of developing the sector-specific technical EIA guidance manuals (TGM) is to provide clear and concise information on EIA to all the stakeholders *i.e*., the project proponent, the consultant, the reviewer, and the public. The TGMs are organized to cover following:

Chapter 1 (Introduction): This chapter provides a brief introduction on the EIA, basic tenets of EIA Notification, technical & operational issues in the process of clearance, purpose of the TGMs, project implementation process and additional information.

Chapter 2 (Conceptual facets of an EIA): Provides an overall understanding to the conceptual aspects of control of pollution and EIA for the developmental projects. This basic understanding would set the readers at same level of understanding for proper interpretations and boundaries for identifying the environmental interactions of the developmental projects and their significance for taking measures of mitigation. This chapter covers the discussion on environment in EIA context *i.e.,* sustainable development, Objectives of EIA, types and basic principles of EIA, project cycle for common municipal solid waste management, understanding on type of environmental impacts and the criteria for the significance analysis.

Chapter 3 (Common Municipal Solid Waste Management): The purpose of this chapter is to provide the reader precise information on all the relevant aspects of the waste management, which is essential to realize the likely interaction of such developmental activities on the receiving environment. Besides, this Chapter gives a holistic understanding on the sources of pollution and the opportunities of the source control.

The specific coverage which provides precise information on the common municipal solid waste management include (i) introduction to common municipal solid waste management and its Indian scenario, (ii) elements of common municipal solid waste management (iii) technological options of common municipal solid waste management, (iv) major concerns and exposure pathways, (v) financial aspects and (vi) the summary of applicable national regulation for this developmental activity.

Chapter 4 (Operational aspects): The purpose of this chapter is to facilitate the stake-holders to extend clear guidance on coverage of legislative requirements, sequence of

procedures for obtaining the EIA clearance and each step-wise provisions and considerations.

The coverage of the Chapter include provisions in the EIA Notification regarding common municipal solid waste management, screening (criteria for categorization of B1 and B2, siting guidelines, *etc*.), scoping (pre-feasibility report, guidance for filling form 1, identification of valued environmental components, identification of impacts, *etc*.), arriving at terms of reference for EIA studies, impact assessment studies (EIA team, assessment of baseline quality of environment, impact prediction tools, significance of impacts), social impact assessment, risk assessment considerations, typical mitigation measures, designing considerations for environmental management plan, structure of EIA report for incorporation of study findings, process of public consultation, project appraisal, decision making process and post-clearance monitoring protocol.

Chapter 5 (Roles and responsibilities of various organizations involved in the process of prior environmental clearance): The purpose of this Chapter is to brief the stakeholders on the institutional mechanism and roles & responsibilities of the stake-holders involved in the process of prior environmental clearance. The Coverage of the Chapter include (i) roles and responsibilities of the stakeholders, (ii) organization specific functions, (iii) constitution, composition and decision making process of SEIAA and (iv) EAC & SEAC and (v) other conditions which may be considered.

For any given sector, each topic listed above could alone be the subject of a lengthy volume. However, in order to produce a manageable document, this project focuses on providing summary information for each topic. This format provides the reader with a synopsis of each issue. Text within each section was researched from many sources, and was condensed from more detailed sources pertaining to specific topics.

The contents of the document are designed with a view to facilitate addressing of the relevant technical and operational issues as mentioned in the earlier section. Besides, facilitates various stakeholders involved in the EIA clearance process *i.e.*

- Project proponents will be fully aware of the procedures, common ToR for EIA studies, timelines, monitoring needs, *etc*., in order to plan the projects/studies appropriately.
- Consultants across India will gain similar understanding about a given sector, and also the procedure for EIA studies, so that the quality of the EIA reports gets improved and streamlined
- Reviewers across the States/UTs will have the same understanding about the sector and would able to draw a benchmark in establishing the significant impacts for the purpose of prescribing the ToR for EIA studies and also in the process of review and appraisal.
- Public who are concerned about new or expansion projects, can use this manual to get a basic idea about the manufacturing/production details, rejects/wastes from the operations, choice of cleaner/control technologies, regulatory requirements, likely environmental and social concerns, mitigation measures, *etc*., in order to seek clarifications appropriately in the process of public consultation. The procedural clarity in the document will further strengthen them to understand the stages involved in clearance and roles and responsibilities of various organizations.
- In addition, these manuals would substantially ease the pressure on reviewers at the scoping stage and would bring in functional efficiency at the central and state levels.

1.2 Project Implementation

The Ministry of Environment & Forests (MoEF), Government of India took up the task of developing sector-specific technical EIA guidance manuals for all the developmental activities listed in the re-engineered EIA Notification. The Infrastructure Leasing and Financial Services Ecosmart Limited (IL&FS Ecosmart), has been entrusted with the task of developing these manuals for 27 industrial and related sectors. Common Municipal Solid Waste Management Facility (CMSWMF) is one of these sectors, for which this manual is prepared.

The ability to design comprehensive EIA studies for specific industries depends on the knowledge of several interrelated topics. Therefore, it requires expert inputs from multiple dimensions *i.e.*, administrative, project management, technical, scientific, social, economic, risk *etc*., in order to comprehensively analyze the issues of concern and to draw logical interpretations. Thus, Ecosmart has designed a well-composed implementation framework to factor inputs of the experts and stakeholders in the process of finalization of these manuals.

The process of manual preparation involved collection & collation of the secondary available information, technical review by sectoral resource persons and critical review and finalization by a competent Expert Committee composed of core and sectoral peer members.

The MoEF appreciates the efforts of Ecosmart, Expert Core and Peer Committee, resource persons and all those who have directly and indirectly contributed to this Manual. .

1.3 Additional Information

This TGM is brought out by the MoEF to provide clarity to all the stakeholders involved in the 'Prior Environmental Clearance' process. As such, the contents and clarifications given in this document do not withstand in case of a conflict with the statutory provisions of the Notifications and Executive Orders issued by the MoEF from time-to-time.

TGMs are not regulatory documents. Instead, these are the tools designed to assist in successful completion of an EIA.

For the purpose of this project, the key elements considered under TGMs are: conceptual aspects of EIA; developmental activity-specific information; operational aspects; and roles and responsibilities of involved stakeholders.

This manual is prepared considering the Notification issued on 14th September, 2006 and its amendments as on 1st December, 2009. For recent updates, if any, may please refer the website of the MoEF, Government of India *i.e.,* http://moef.nic.in/index.php.

2. CONCEPTUAL FACETS OF EIA

It is an imperative requirement to understand the basic concepts concerned to the pollution control and the environmental impact assessment in an overall objective of the sustainable development. This Chapter highlights the objectives, types & principles of EIA, type of impacts their significance analysis, in order to provide consistent understanding to the reader before assessing the development of activity-specific environmental concerns in Chapter 3 and identification & prediction of significant impacts in order to design mitigation measures as detailed in Chapter 4.

2.1 Environment in EIA Context

"Environment" in EIA context mainly focuses, but is not limited to physical, chemical, biological, geological, social, economical, and aesthetic dimensions along with their complex interactions, which affect individuals, communities and ultimately determines their forms, character, relationship, and survival. In EIA context, 'effect' and 'impact' can often be used interchangeably. However, 'impact' is considered as a value judgment of the significance of an effect.

Sustainable development is built on three basic premises *i.e.*, economic growth, ecological (and environmental) balance and social progress. Economic growth achieved in a way that does not consider the environmental concerns, will not be sustainable in the long run. Therefore, sustainable development needs careful integration of environmental, economic, and social needs in order to achieve both an increased standard of living in short term, and a net gain or equilibrium among human, natural, and economic resources to support future generations in the long term.

It is necessary to understand the links between environment and development in order to make choices for development that will be economically efficient, socially equitable and responsible, as well as environmentally sound.

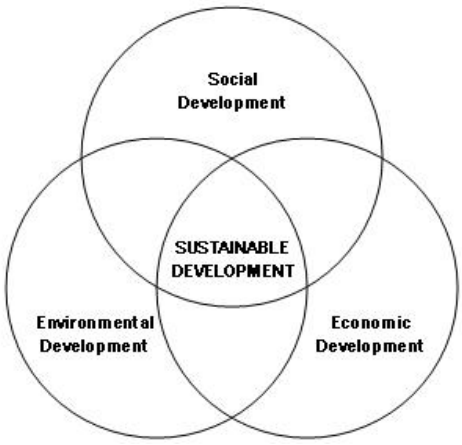

Figure 2-1: Inclusive Components of Sustainable Development

2.2 Objectives of EIA

Objectives of EIA include the following:

- To ensure environmental considerations are explicitly addressed and incorporated into the development decision-making process;
- To anticipate and avoid, minimize or offset the adverse significant biophysical, social and other relevant effects of development proposals;
- To protect the productivity and capacity of natural systems and the ecological processes which maintain their functions; and
- To promote development that is sustainable and optimizes resource use as well as management opportunities

2.3 Types of EIA

Environmental assessments could be classified into four types *i.e*. strategic environmental assessment (SEA), regional EIA, sectoral EIA and project level EIA. These are precisely discussed below:

Strategic environmental assessment

SEA refers to systematic analysis of the environmental effects of development policies, plans, programmes and other proposed strategic actions. SEA represents a proactive approach to integrate environmental considerations into the higher levels of decision-making – beyond the project level, when major alternatives are still open.

Regional EIA

EIA in the context of regional planning integrates environmental concerns into development planning for a geographic region, normally at the sub-country level. Such an approach is referred to as the economic-cum-environmental (EcE) development planning. This approach facilitates adequate integration of economic development with management of renewable natural resources within the carrying capacity limitation to achieve sustainable development. It fulfils the need for macro-level environmental integration, which the project-oriented EIA is unable to address effectively. Regional EIA addresses the environmental impacts of regional development plans and thus, the context for project-level EIA of the subsequent projects, within the region. In addition, if environmental effects are considered at regional level, then cumulative environmental effects of all the projects within the region can be accounted.

Sectoral EIA

Instead of project-level-EIA, an EIA should take place in the context of regional and sectoral level planning. Once sectoral level development plans have the integrated sectoral environmental concerns addressed, the scope of project-level EIA will be quite minimal. Sectoral EIA helps in addressing specific environmental problems that may be encountered in planning and implementing sectoral development projects.

Project level EIA

Project level EIA refers to the developmental activity in isolation and the impacts that it exerts on the receiving environment. Thus, it may not effectively integrate the cumulative effects of the development in a region.

From the above discussion, it is clear that EIA shall be integrated at all the levels *i.e.* strategic, regional, sectoral and the project level. Whereas, the strategic EIA is a structural change in the way the things are evaluated for decision-making, the regional EIA refers to substantial information processing and drawing complex inferences. The project-level EIA is relatively simple and reaches to meaningful conclusions. Therefore in India, project-level EIA studies take place on a large scale and are being considered. However, in the re-engineered Notification, provisions have been incorporated for giving a single clearance for the entire industrial estate for e.g., Leather parks, pharma cities *etc*., which is a step towards the regional approach.

As we progress and the resource planning concepts emerge in our decision-making process, the integration of overall regional issues will become part of the impact assessment studies.

Thus the SEA, Regional EIA, and Sectoral EIA evaluate environmental, social and ecological effects on a larger scale and may be considered as tools for the development of framework of planning at country, sub-country and regional levels, while the project level EIA focuses on developmental activity of a proposed project in a given location. In identifying the project (site as well as the proposed activities), due consideration to the urban land use planning issues should be given.

2.4 Basic EIA Principles

By integrating the environmental impacts of the development activities and their mitigation early in the project planning cycle, the benefits of EIA could be realized in all stages of a project, from exploration and planning, through construction, operations, decommissioning, and beyond site closure.

A properly-conducted-EIA also lessens conflicts by promoting community participation, informing decision makers, and also helps in laying the base for environmentally sound projects. An EIA should meet at least three core values:

- Integrity: The EIA process should be fair, objective, unbiased and balanced
- Utility: The EIA process should provide balanced, credible information for decision-making
- Sustainability: The EIA process should result in environmental safeguards

Ideally an EIA process should be:

- Purposive - should inform decision makers and result in appropriate levels of environmental protection and community well-being.
- Rigorous - should apply ‘best practicable’ science, employing methodologies and techniques appropriate to address the problems being investigated.
- Practical - should result in providing information and acceptable and implementable solutions for problems faced by proponents.

- Relevant - should provide sufficient, reliable and usable information for development planning and decision making.
- Cost-effective - should impose minimum cost burdens in terms of time and finance on proponents and participants consistent with meeting accepted requirements and objectives of EIA.
- Efficient - should achieve the objectives of EIA within the limits of available information, time, resources and methodology.
- Focused - should concentrate on significant environmental effects and key issues; *i.e.,* the matters that need to be taken into account in making decisions.
- Adaptive - should be adjusted to the realities, issues and circumstances of the proposals under review without compromising the integrity of the process, and be iterative, incorporating lessons learned throughout the project life cycle.
- Participative - should provide appropriate opportunities to inform and involve the interested and affected publics, and their inputs and concerns should be addressed explicitly in the documentation and decision making.
- Inter-disciplinary - should ensure that appropriate techniques and experts in the relevant bio-physical and socio-economic disciplines are employed, including use of traditional knowledge as relevant.
- Credible - should be carried out with professionalism, rigor, fairness, objectivity, impartiality and balance, and be subject to independent checks and verification.
- Integrated - should address the interrelationships of social, economic and biophysical aspects.
- Transparent - should have clear, easily understood requirements for EIA content; ensure public access to information; identify the factors that are to be taken into account in decision making; and acknowledge limitations and difficulties.
- Systematic - should result in full consideration of all relevant information on the affected environment, of proposed alternatives and their impacts, and of the measures necessary to monitor and investigate residual effects.

2.5 Project Cycle

The generic project cycle including that of CMSWMF has six main stages:

1. Project concept
2. Pre-feasibility
3. Feasibility
4. Design and engineering
5. Implementation
6. Monitoring and evaluation

It is important to consider the environmental factors on an equal basis with technical and economic factors throughout the project planning, assessment and implementation phases. Environmental considerations should be introduced at the earliest in the project cycle and must be an integral part of the project pre-feasibility and feasibility stage. If the Environmental considerations are given due respect in site selection process by the project proponent, the subsequent stages of the environmental clearance process would

get simplified and would also facilitate easy compliance to the mitigation measures throughout the project life cycle.

A project's feasibility study should include a detailed assessment of significant impacts and the EIA include the detailed prediction and quantification of impacts and delineation of Environmental Management Plan (EMP). Findings of the EIA study should preferably be incorporated in the project design stage so that the project as well as the site alternatives is studied and necessary changes, if required, are incorporated in the project design stage. This practice will also help the management in assessing the negative impacts and in designing cost-effective remedial measures. In general, EIA enhances the project quality and improves the project planning process.

2.6 Environmental Impacts

Environmental impacts resulting from proposed actions can be grouped into following categories:

- Beneficial or detrimental
- Naturally reversible or irreversible
- Repairable via management practices or irreparable
- Short term or long term
- Temporary or continuous
- Occurring during construction phase or operational phase
- Local, regional, national or global
- Accidental or planned (recognized before hand)
- Direct (primary) or Indirect (secondary)
- Cumulative or distinct (single)

The category of impact as stated above, and the significance will facilitate the Expert Appraisal Committee (EAC)/State Level EAC (SEAC) to take a look at the ToR for EIA studies, as well as, in decision making process about the developmental activity.

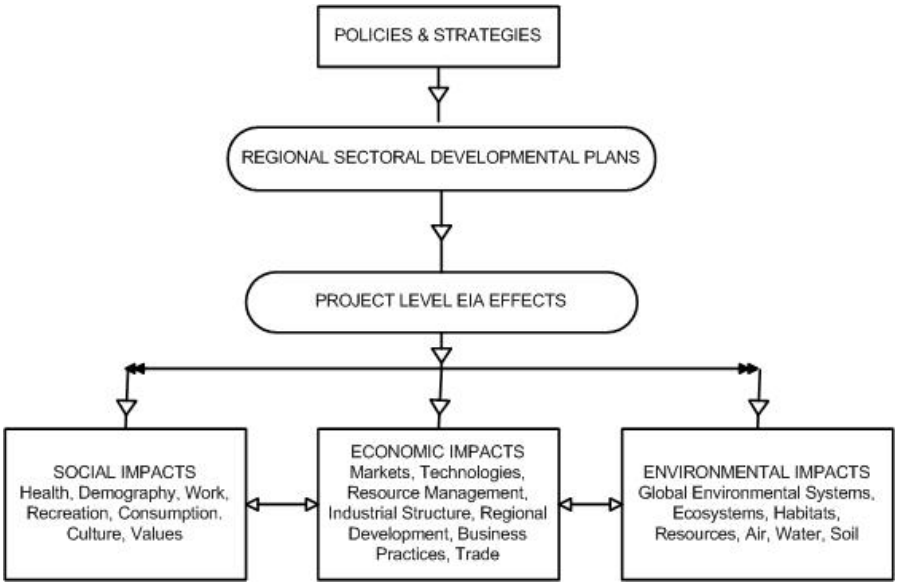

Figure 2-2: Types of Impacts

The nature of impacts could fall within three broad classifications *i.e.*, direct, indirect and cumulative, based on the characteristics of impacts. The assessment of direct, indirect and cumulative impacts should not be considered in isolation or considered as separate stages in the EIA. Ideally, the assessment of such impacts should form an integral part of all stages of the EIA. The TGM does not recommend a single method to assess the types of impacts, but suggests a practical framework/approach that can be adapted and combined to suit a particular project and the nature of impacts.

2.6.1 Direct impacts

Direct impacts occur through direct interaction of an activity with an environmental, social, or economic component. For example, migration or transport of leachate containing suspended solids and pathogens from the waste disposal site into a nearby water body may lead to degradation in water quality in terms of high biological oxygen demand (BOD) or dissolved oxygen (DO) or rise of water toxins polluting the ground and surface waters. Another example of direct impact would be emissions of methane and carbon dioxide gases which shall aggravate the ambient air pollution concentrations.

2.6.2 Indirect impacts

Indirect impacts on the environment are those which are not a direct result of the project, often produced away from or as a result of a complex impact pathway. The indirect impacts are also known as secondary or even third level impacts. For example, health impacts due to toxic gas emissions, contamination of soils due to leachate that is generated, odours from the solid waste, noise due to constructions at the facility, *etc*. Some of the impacts are characterized as socio-economic (third level) impacts. The indirect impacts may also include growth-inducing impacts and other effects related to induced changes to the pattern of land use or additional road network, population density or growth rate (e.g. around a disposal site). In the process, air, water and other natural systems including the ecosystem may also be affected. Indirect impacts could be both positive and negative, for example: on one hand, the proposed project may increase the potential for employment and development of ancillary industry and on the other because of the pollution potential and on aesthetic considerations, the land values may diminish in the immediate surroundings of the proposed disposal site.

2.6.3 Cumulative impacts

Cumulative impact consists of an impact that is created as a result of the combination of the project evaluated in the EIA together with other projects causing related impacts. These impacts occur when the incremental impact of the project is combined with the cumulative effects of other past, present and reasonably foreseeable future projects. Figure 2-3 depicts the same. Respective EAC may exercise their discretion on a case-by-case basis for considering the cumulative impacts.

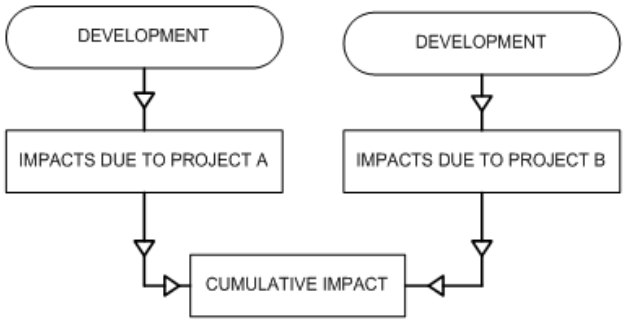

Figure 2-3: Cumulative Impact

2.6.4 Induced impacts

The cumulative impacts can be due to induced actions of projects and activities that may occur if the action under assessment is implemented such as growth-inducing impacts and other effects related to induced changes to the pattern of future land use or additional road network, population density or growth rate (e.g., excess growth may be induced in the zone of influence around the disposal facility, (particularly poorer sections of the community), and in the process causing additional effects on air, water and other natural ecosystems). Induced actions may not be officially announced or be part of any official plan. Increase in workforce (due to growth of formal or informal ancillary industry like rag picking, recycling, *etc.*) and nearby communities contributes to this effect.

They usually have no direct relationship with the action under assessment, and represent the growth-inducing potential of an action. New roads leading from those constructed for a project, increased recreational activities *(e.g.,* hunting, fishing), and construction of new service facilities are examples of induced actions.

However, the cumulative impacts due to induced development or third level or even secondary indirect impacts are difficult to be quantified. Because of higher levels of uncertainties, these impacts cannot normally be assessed over a long time horizon. An EIA practitioner usually can only guess as to what such induced impacts may be and the possible extent of their implications on the environmental factors. Respective EAC may exercise their discretion on a case-by-case basis for considering the induced impacts.

2.7 Significance of Impacts

This TGM establishes the significance of impacts first and proceeds to delineate the associated mitigation measures. So the significance here reflects the "worst-case scenario" before mitigation is applied, and therefore provides an understanding of what may happen if design measures of mitigation fails or are not as effective as predicted. For establishing significance of different impacts, understanding the responses and interaction of the environmental system is essential. Hence, the impact interactions and pathways are to be understood and established first. Such an understanding will help in the assessment process to quantify the impact as accurately as possible. Complex interactions, particularly in the case of certain indirect or cumulative impacts, may give rise to non-linear responses which are often difficult to understand and therefore their significance is difficult to assess. It is hence understood that indirect or cumulative impacts are more complex than the direct impacts. Currently the impact assessments are limited to direct impacts. In case mitigation measures are delineated before determining significance of the effect, the significance represents the residual effects.

However, the ultimate objective of an EIA is to achieve sustainable development. The development process shall invariably cause some residual impacts even after implementing an EMP effectively. Environmentalists today are faced with a vital, not-easy-to-answer question—"What is the tolerable (or reasonable) level of environmental impact within the sustainable development framework?" As such, it has been recognized that every ecosystem has a threshold for absorbing deterioration and a certain capacity for self-regeneration. These thresholds based on concept of carrying capacity are as follows:

- Waste emissions from a project should be within the assimilative capacity of the local environment to absorb without unacceptable degradation of its future waste absorptive capacity or other important services.
- Harvest rates of renewable resource inputs should be within the regenerative capacity of the natural system that generates them; depletion rates of non-renewable inputs should be equal to the rate at which renewable substitutes are developed by human invention and investment.

The aim of this model is to curb over-consumption and unacceptable environmental degradation. But because of limitation in available scientific basis, this definition provides only general guidelines for determining the sustainable use of inputs and outputs. To establish the level of significance for each identified impact, a three-stage analysis may be referred:

- First, an impact is qualified as being either negative or positive.
- Second, the nature of impacts such as direct, indirect, or cumulative is determined using the impact network
- Third, a scale is used to determine the severity of the effect; for example, an impact is of low, medium, or high significance.

It is not sufficient to simply state the significance of the effect. This determination must be justified, coherent and documented, notably by a determination methodology, which must be described in the methodology section of the report.

2.7.1 Criteria/methodology to determine the significance of the identified impacts

The criteria can be determined by answering some questions regarding the factors affecting the significance. This will help the EIA stake-holders, the practitioner in particular, to determine the significance of the identified impacts eventually. Typical examples of such factors include the following:

- Exceeding threshold Limit: Significance may increase if a threshold is exceeded. e.g., Emissions of particulate matter exceed the permissible threshold.
- Effectiveness of mitigation: Significance may increase as the effectiveness of mitigation measures decreases. e.g., control technologies, which may not assure consistent compliance to the requirements.
- Size of study area: Significance may increase as the zone of effects increases.
- Incremental contribution of effects from action under review: Significance may increase as the relative contribution of an action increases.
- Relative contribution of effects of other actions: Significance may decrease as the significance of nearby larger actions increase.

- Relative rarity of species: Significance may increase as species becomes increasingly rare or threatened.
- Significance of local effects: Significance may increase as the significance of local effects is high.
- Magnitude of change relative to natural background variability: Significance may decrease if effects are within natural assimilative capacity or variability.
- Creation of induced actions: Significance may increase as induced activities also highly significant.
- Degree of existing disturbance: Significance may increase if the surrounding environment is pristine.

For determining significance of impacts, it is important to remember that secondary and higher order effects can also occur as a result of a primary interaction between a project activity and the local environment. Wherever a primary effect is identified, the practitioner should always think if secondary or tertiary effects on other aspects of the environment could also arise.

The EIA should also consider the effects that could arise from the project due to induced developments, which take place as a consequence of the project. Ex. Population density and associated infrastructure and jobs for people attracted to the area by the project. It also requires consideration of cumulative effects that could arise from a combination of the effects due to other projects with those of other existing or planned developments in the surrounding area. So the necessity to formulate a qualitative checklist is suggested to test significance, in general.

3. ABOUT COMMON (CENTRALIZED) MUNICIPAL SOLID WASTE MANAGEMENT FACILITY INCLUDING BEST PRACTICES AND POLLUTION CONTROL TECHNOLOGIES

3.1 Introduction to the Municipal Solid Waste Management

Municipal solid waste (MSW) includes waste from households, non-hazardous solid waste from industrial, commercial and institutional establishments (excluding bio-medical waste in present context), market waste, yard waste, agricultural wastes and street sweepings. Industrial and community hazardous waste and infectious waste, is not considered as MSW and should be collected and processed separately. MSW (Management and Handling) Rules 2000 defines MSW as "commercial and residential wastes generated in municipal or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes". Various other definitions related to MSW, which are defined in MSW Rules 2000, are given in **Annexure I**. MSW management encompasses the functions of collection, transfer & transportation, processing & recycling, and disposal of MSW.

Safe and cost-effective management of MSW is a significant environmental challenge for modern society. Inadequately managed waste disposal has the potential to affect the health and environment.

Ideally MSW management should incorporate the principles of waste minimization, recycling, resource recovery as well as an integrated processing & disposal facility, leading to effective service delivery in a sustainable manner.

Management of solid waste is required at all stages from waste generation to the final disposal. An integrated solid waste management plan would consist of:

- understanding the current waste management practices
- identifying waste management needs
- setting priorities for actions required
- identifying budget needs
- coordinating with different stakeholders
- measuring progress in terms of targets achieved
- modifying priorities as the plan develops
- communicating and coordinating with the external agencies/local agencies to achieve the targets

For the purpose of EIA Notification, common municipal solid waste management facilities may be referred as centralized MSW facility for an given town, city, region. It is further to mention a common facility need not have surrounding ULBs included.

3.1.1 Solid waste management in Indian scenario

The rapid urbanization is changing the nature of solid waste management from a low priority, localized issue to a pervasive social and environmental problem with risks to public health and environment.

MSW management is constrained by institutional weakness, lack of proper funding, lack of proper management and operational systems, public apathy, lack of municipal will to become financially self-sufficient through municipal taxation, *etc*.

In Indian towns, MSW storage is at a centralized place. Individuals deposit their waste in bins/enclosures located at street corners at specific intervals. The containers generally are constructed of metal, concrete, or brick masonry. Indiscriminate littering of roads and drains is also common in most cities and towns. Community storage may reduce the cost of waste collection, but chances of littering remains. Scavenging of the wastes by rag-pickers and stray animals lead to further scattering of solid waste.

It is often perceived by the municipal authorities that the lack of civic awareness among city residents is proving to be a major hurdle in maintaining the cleanliness. The problem is most acute in slums and in areas where the lower and middle income groups reside. Because of the poor conditions for temporary storage of wastes, in some areas, NGOs are involved in making arrangements for waste collection from households leading to improvement in street cleanliness.

Different types of vehicles, varying from bullock carts to compactors, are used for transportation of waste. However, the general-purpose open body trucks of 5 to 9 tones capacity are in common use. In smaller towns, tractor-trailers are used despite being slow. In few cities, compactor vehicles are also being used. The waste is transported mostly by municipal vehicles; though, in some large towns, private vehicles are also hired to augment the fleet size. The maintenance of the vehicles is carried out in the general municipal workshop along with other municipal vehicles where usually the municipal refuse vehicles do not receive the priority. Most of these workshops have facilities for minor repairs only. Although preventive maintenance is necessary to maintain collection fleet in proper operating condition, this aspect is often neglected. Transfer stations are available only in few metropolitan cities.

Several thousands of urban dwellers in India make their living upon waste processing by working in small industries, which recycle plastics, tin cans, bottles, bones, hair, leather, glass, metal *etc.,* recovered from MSW. Most of the material containing metals, unsoiled paper, plastics, glass, cardboard, *etc.* are marketable and hence recycled by householders themselves or by the rag-pickers. By the time waste reaches the community bins, it contains only a small portion of recyclable material and consists mainly of vegetable/fruit peelings, scraps of soiled paper and plastic, used toiletries, and inert material such as sand and stones, *etc*.

The larger proportion of organic matter in MSW indicates the desirability of biological processing of waste such as composting. Though composting has been the prevalent biological processing practiced in India, there have been problems due to transportation, poor acceptance by farmers (may be because of quality concerns), marketing, price *etc*. Recently efforts are being taken to popularize waste segregation and composting. Characteristics of the Indian MSW bring out the fact that a self-sustaining combustion reaction cannot be obtained with a majority of Indian MSW and auxiliary fuel will be required to aid waste combustion.

In majority of urban centers, waste is being disposed of in low-lying areas. The disposal sites are selected on the basis of their proximity to the collection areas and new disposal sites are normally identified only when the existing ones are filled. In most cases, the waste is simply dumped at such sites and, except in the major cities, bulldozers are rarely used for compaction at the disposal site. Even in these cities, they are used mainly for leveling of the deposited waste. Proper weighing, filling and soil layering are not practiced in many areas. Provisions for leachate and gas control do not exist at many places. A soil cover is rarely provided, except at the time of final closure of the site. Most of the disposal sites are unfenced and the waste picking is commonly in vogue, posing problems in the operation of the sites. It is a common practice to light a fire on the dumpsite by the rag-pickers either to reduce the menacing flies and volume or odour and facilitate waste picking.

In view of the difficulty in acquiring land for establishing waste management and disposal facilities, it is imperative that the existing dumpsites are redesigned to receive present and future wastes. As haphazard dumping across the dumpsites has been a common practice, and contamination of the surrounding areas is not uncommon, those dumpsites need to be rehabilitated and redesigned to recover space for future wastes. The rehabilitation measures should include measures to contain the contaminant migration and where possible lining the base of the fill and design it to receive future wastes for a period of 20 years of more through innovative designs and well planned operations and maintenance.

3.1.2 MSW – A growing challenge

Over the next two decades, growing urbanization in India will result in a massive increase of waste. By the year 2021, the urban population is expected to represent 41% of the overall population. A study conducted by the CPCB on management of MSW in the country estimates that waste generation from the present 48 million tones (MT) per year is expected to increase to 300 MT per year, by the year 2047 (490 g per capita to 945 g per capita). The estimated requirement of land for disposal would be 169.6 square kilometer (km^2) in 2047 as against 20.2 km^2 in 1997 (CPCB 2000a).

- India produces 48.0 MT of MSW annually at present.
- Urban population increasing between 3 – 3.5 % per annum.
- Per capita waste generation in India is increasing by 1.3 % per annum.
- Yearly increase of waste generation in India is around 5%.

To tackle the waste generated in urban areas, the urban local bodies are investing around 35 -50 % of its available funds, spending about Rs. 500-1500 per ton on solid waste management. Hence there is an urgent need to increase efficiency for better service delivery and optimization.

Land disposal of solid wastes has been practiced for centuries. Municipal, industrial, agricultural and urban activities produce huge amounts of wastes, which require safe and permanent secured disposal. In view of growing challenge of solid waste management in the country, the Central Government has incorporated solid waste management as one of the components in the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) programme, initiated by the Central Government for extending financial resources. Many cities are getting benefit from this massive programme.

3.1.2.1 Issues and indicators

There are several aspects of solid waste management: technical, financial, institutional and social. Each of these aspects has certain issues, which need to be deliberated upon to achieve sustainable and effective waste management. The implementation and progress can be monitored by evolving certain indicators, which are discussed below:

A. Technical issues

- Inadequate technical expertise and planning capability in most of the urban local bodies (ULBs)
- Technical expertise available with some of the metro and mega cities is not fully utilized and not given due weightage in decision making
- Inadequate solid waste management plans in the system at local and national levels
- Low priority for research and development in solid waste management sector
- Selection of appropriate technology for handling and disposal of solid waste is often left open in the tenders
- Considerable work is required to be done on recycling, parameters of health and safety of recycled products, *etc*.
- Competitive market not yet developed for procurement of plant and equipment for processing MSW and other solid waste materials

Indicators

- Quality and extent (coverage) of service provided
- Impact on health and environment

B. Financial issues

- ULBs are unable to generate adequate funds from their own sources, such as municipal taxes (as mandated by the 74th Constitutional Amendment Act)
- Good financial management and planning for the available resources by the local government
- Additional support from users through user charges as supplement to property tax

C. Institutional issues

- Coordination of solid waste management projects and activities by dedicated department / cell in each ULB
- Inadequate coordination between the relevant agencies
- Enforcement of applicable Rules and regulations by the ULB
- Provision of clear mandates and sufficient resources to fulfill the mandates by the ULBs
- Only environment friendly sustainable options to be implemented by local government

- Nodal department in the State Government (Municipal Administration / Urban Development) should provide guidance and oversee implementation of applicable Rules

Indicators

- Self-sufficiency within the ULBs for tackling MSW management

D. Social issues

- Lack of public awareness and school education programmes
- Lack of genuine interest amongst the public and other stakeholders
- Low paid employment for waste workers
- Waste workers have very low social status

Indicators

- Public cooperation
- Social equity for the waste workers

3.2 Elements of MSW Management

The activities associated with the management of MSW from the start of waste generation to final disposal can be grouped into the six functional elements:

- waste generation
- waste storage at source
- waste segregation
- collection (primary and secondary)
- transportation
- processing and recycling
- disposal of reject material
- rehabilitation of the existing dumpsites to mitigate the pollution potential

3.2.1 Waste generation

Waste generation encompasses activities, in which materials (in their present form) are identified valueless and are either thrown away or gathered for disposal. Waste generation is, at present, an activity that is not very controllable. In future, however, more control is likely to be exercised over the generation of wastes. Reduction of waste at source, although not controlled by solid waste managers, is now included in system evaluations as a method of limiting the quantity of waste generated.

Currently, proponents of most MSW projects estimate the waste generation rates based on average per capita rates provided by the CPCB. More accurate estimates of waste generation rates and analysis of waste characteristics would be required to evaluate options for the design of waste diversion systems, waste processing and disposal facilities.

3.2.1.1 Quantity of solid waste

It is estimated that solid waste generated in small, medium and large cities and towns is about 0.1 kg, 0.3 – 0.4 kg and 0.5 kg per capita per day respectively.

As per the Ministry of Urban Development's (MoUD) manual on solid waste management (year 2000) the estimated waste generation in the country is 100,000 TPD. CPCB in assistance with NEERI has survey records of waste generation and characteristics for 59 cities (35 Metro Cities and 24 State Capitals: 2004-05) of the country. The list of these waste generation rates and waste characterizations are given in **Annexure II**.

3.2.1.2 Composition of solid waste

It is very important to understand the sources of MSW and the typical composition, before reviewing the choice of technologies.

MSW composition can vary substantially with location and time depending on many factors, including socio-economic, climatic conditions, living standards, waste collection, and disposal methods, sampling and sorting procedures. MSW is heterogeneous in nature and consists of number of different materials derived from various types of activities which includes residential, commercial, and non-hazardous industrial waste but exclude combustion ash, hazardous waste, sludge, and industrial process wastes. A diagram depicting the typical sources of MSW is given in Figure 3.1.

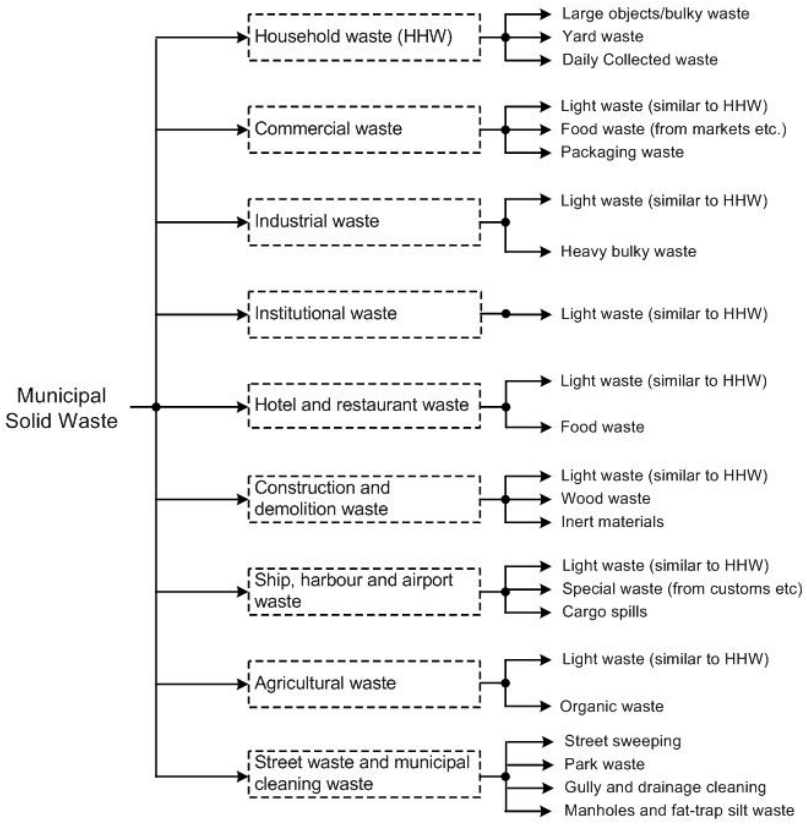

Figure 3-1: Type and Composition of MSW

It can be seen from the Figure 3-1, that there are number of sources for MSW. Depending on the serving area, the source may vary and accordingly the final composition of MSW. Waste composition categories include organic material (biodegradable) and inorganic material (non-biodegradable). Inorganic portion is mostly occupied by inert material but also include paper, plastics, glass, paper, plastics, glass, rubber, *etc*.

3.2.1.3 Characteristics of MSW

Physical Characteristics

Physical characteristics of MSW are density, moisture content, size of the waste constituents, calorific value, *etc*.

The density of solid waste may vary during transportation of waste from its source to disposal points. Density of waste is an important measure which is used to define all the elements of the solid waste management system such as storage, transportation and disposal facilities required. Compaction of waste increases the density in order to accommodate larger quantities of waste within the available space.

Moisture content of solid wastes is usually expressed as the weight of moisture per unit weight of wet material. Moisture increases the weight of solid waste, thereby increasing the cost of collection and transportation. Therefore moisture content is a critical component in the economic feasibility of waste treatment and processing methods by incineration.

$$\text{Moiture Content}\,(\%) = \frac{\text{Wet weight} - \text{Dry weight}}{\text{Wet weight}} \times 100$$

Size of waste constituents is important in the design of mechanical separators and shredders and also in waste treatment process.

Calorific value is the amount of heat generated from combustion of a unit weight of a substance, expressed as kcal/kg and determined using a bomb calorimeter. Calorific value indicates its suitability for incineration.

Chemical Characteristics

Knowledge of chemical characteristics of waste is essential in understanding the behavior of waste all through the waste management system and also in selecting and determining the efficiency of any treatment process. Further, the characteristics of leachate that could potentially contaminate the surrounding water resources depend on the waste characteristics. Chemical characteristics include (i) chemical; (ii) bio-chemical; and (iii) toxic characteristics.

- Chemical characteristics include pH, Nitrogen, Phosphorus and Potassium (N-P-K), total Carbon, C/N ratio, *etc*.
- Bio-Chemical characteristics include carbohydrates, proteins, natural fibre, and biodegradable factor, *etc*.
- Toxicity characteristics include heavy metals, pesticides, insecticides, Toxicity test for Leachates (TCLP), *etc*.

Knowledge of chemical characteristics is essential in selecting and designing the waste processing and disposal facilities.

3.2.2 Waste handling, sorting, storage, and processing at the source

The second functional element in the solid waste management system is waste handling, sorting, storage, and processing at the source. Waste handling and sorting involves the activities associated with management of wastes until they are placed in storage containers for collection. Handling also encompasses the movement of loaded containers to the point of collection. Sorting of waste components is an important step in the handling and storage of solid waste at the source. For example, the best place to separate waste materials for reuse and recycling is at the source of generation. Households are becoming more aware of the importance of separating newspaper and cardboard, bottles/glass, kitchen wastes and ferrous and non-ferrous materials. On-site storage is of primary importance because of public health concerns and aesthetic consideration. Unsightly makeshift containers and even open ground storage, both of which are undesirable, are often seen at many residential and commercial sites. The cost of providing storage for solid wastes at the source is normally borne by the household in the case of individuals, or by the management of commercial and industrial properties. Processing at the source involves activities such as backyard waste composting.

3.2.3 Collection and storage of MSW

Collection and storage of MSW is an important issue which has great impact on the overall solid waste management. Community / municipal storage based system was mostly used in our cities. Lately, there is increased stress on door-step collection for better service delivery and controlling littering as well as unauthorized dumping of municipal garbage.

The functional element of collection includes not only the gathering of solid wastes and recyclable materials, but also the transport of these materials, after collection, to the location where the collection vehicle is emptied. This location may be materials processing facility, a transfer station, or a landfill disposal site.

3.2.3.1 Door-to-door collection

Current practices of waste collection in residential areas differ from city to city and even sometimes within the city. Door-to-door collection is not widely practiced. Door-to-door (or house-to-house collection is the responsibility of the ULBs as per Schedule II, compliance criteria 1. The local authorities should arrange for primary collection of waste from sources of waste generation. Door-to-door collection of waste can be carried out with handcarts, tricycles or any small motorized vehicles having bell or horns as a means of announcing the arrival of collection staff with active public participation. Wastes from private societies, multistoried buildings, commercial complexes, *etc*. are collected through community bins. Lane wise or door step or community bin waste collection can be followed for slum areas. Based on the density of population in the area, work can be assigned either to the sweeper or tricycle staff for collecting wastes. Local authorities are vested with the responsibility for planning the collection of waste in a productive manner.

NGOs, private operators may be encouraged by local authorities to collect biodegradable or recyclable wastes from door steps by making contractual arrangement either with the

local bodies or directly with the residents to reduce the financial burden on local bodies. NGOs may be activated to organize the rag pickers for collection of recyclable waste either from doorstep in case waste segregation at source by improving the quality of life and reduce health risk to rag pickers or from streets, bins, and dump yard if not segregated thereby providing employment to the rag pickers.

Measures, which could be followed for collection of segregated waste include:

- Collection of segregated waste
- Participation of NGO/private company in collecting wastes from door steps by reducing the financial burden of local bodies
- Use of bells or horns by the tricycle staff with public participation without loss of time
- Improving the quality of life of rag pickers from segregating waste at source
- Proper use of community bins
- Waste collection through tricycles, motorized vehicles
- Collection of recyclable waste by rag pickers from shops and establishments soon as they open in the morning
- Collection of vegetable, fruit, meat, fish wastes from the markets on a daily basis
- Collection of hotel and restaurant waste on a full cost recovery basis and door step service may be contracted by local bodies if desired.
- Collection of garden waste on weekly basis.
- Collection of waste from marriage halls, community halls and commercial centers daily on full cost recovery basis.
- Collection of construction and demolition waste on rate per ton basis as prescribed by the local bodies. These charges should be paid in advance before removing the waste.
- Dairy and cattle shed waste is collected daily and sent to specified municipal storage containers nearby at regular intervals by local bodies.

3.2.3.2 Segregation of waste

Waste segregation is the first step towards waste diversion and reduction. In order that the MSW management systems and waste treatment facilities work efficiently and for extending the life of the waste disposal facilities, it is imperative that waste is properly segregated early in the systems management. To encourage citizens, municipal authorities shall organize awareness programmes for segregation of wastes and shall promote recycling or reuse of segregated materials.

Municipal authorities shall undertake phased programme to ensure community participation in waste segregation. For this, regular meetings at quarterly intervals may be arranged by the municipal authorities with representatives of local resident's welfare association (RWAs), NGOs and representatives of other informal sector (such as rag pickers). In the MSW management, the informal sector plays a very important role and it should be recognized and efforts to improve their work environment could go a long way is establishing sustainable MSW management systems.

- Segregation at the collection point/source reduces the cost of processing and disposal
- Separation at site by rag pickers for recycling

- Incentives for segregation otherwise punitive action

3.2.4 Sorting, processing and transformation of solid waste

The sorting, processing and transformation of solid waste materials is the fourth functional element. The recovery of sorted materials, processing of solid waste and transformation of solid waste that occurs primarily in locations away from the source of waste generation are encompassed by this functional element. At present, sorting of commingled (mixed) wastes usually occur at a materials recovery facility, transfer stations, combustion facilities, and disposal sites. Sorting often includes the separation of bulky items, separation of waste components by size using screens, manual separation of waste components, and separation of ferrous & non-ferrous metals. . In order to save on costs of transportation, sorting is best done at the source and different waste items are collected separately and transported to respective processing facilities by the ULBs or their designated agents.

The recyclable wastes, if handled and managed properly, could form a major part of revenue resource. The existence of large number of rag pickers and some of the thriving recycling industries in many of the large cities is evidence to this fact. The municipal authorities should recognise this fact and establish appropriate mechanisms for collection and sale of the recyclable materials without impacting the livelihood of the rag pickers community and the related industry.

Waste processing is undertaken to recover conversion of products and energy. The organic fraction of MSW can be transformed by a variety of biological and thermal processes.

Waste transformation is undertaken to reduce the volume, weight, size or toxicity of waste without resource recovery. Transformation may be done by a variety of mechanical (*e.g.* shredding) / thermal (*e.g.* incineration) / chemical (*e.g.* encapsulation) techniques.

3.2.5 Transfer and transport

The functional element of transfer and transport involves two steps:

- the transfer of wastes from the smaller collection vehicles such as tricycles to the larger transport equipment, usually at transfer station and
- the subsequent transportation of wastes from transfer station to the processing or disposal site.

Transfer station

A transfer station is a solid waste processing site where solid waste is transferred from one vehicle to another vehicle or to storage device for temporary storage until transferred to a permanent disposal site approved or permitted by the appropriate Authority or any other appropriate Authority having jurisdiction over the location of the permanent disposal site. Location of transfer stations should be well identified after examining traffic routes for the transportation of wastes for smooth traffic movement and safety of the local community. To know the waste generation rates and waste characterization regular field investigations and inspections can be carried out at these transfer stations. The transfer stations could be designed in a manner that recyclable wastes that are not picked at the

primary collection points are segregated, stored and sold or transported to relevant processing facilities. Transfer stations shall be well equipped with appropriate facilities and equipments to handle these activities and to avoid pollution.

In general, it is observed that waste collection and transportation costs to 70-90% of the municipal MSW management budget, leaving a paltry portion for waste processing and disposal. Hence, in order to achieve economic sustainability, the proponents of IMSWM systems should need to pay special attention to these two functional elements in optimising their costs and also develop revenue earning systems for appropriate processing and treatment facilities.

3.2.6 Disposal

The final functional element in the solid waste management system is disposal. Today the disposal of wastes by landfilling or uncontrolled dumping of commingled (mixed) wastes is the ultimate activity of solid waste management, whether they are residential wastes collected and transported directly to a landfill site, residual materials from materials recovery facilities, residue from the combustion of solid waste, rejects of composting, or other substances from various solid waste-processing facilities. Currently, in a large number of cities do not have any processing facilities and the municipalities tend to haphazard dumping of wastes all over the dumpsite(s).

In order to mitigate potential impacts of waste disposal, a MSW landfill is to be designed as an engineered facility used for disposing solid wastes on land without creating nuisance or hazard to public health or safety, such as breeding of rodents, insects and contamination of surrounding natural environment, including groundwater and surface water resources and air quality.

3.3 Technological Aspects

Considering India's diversity in-respect of cultural, socio-political, geographical, meteorological and economical aspects; it is unlikely that a single model for MSW management is acceptable for application across the country. While the location specific considerations largely influence the choice of applicable technology, there are generic factors which are more or less in common. The MSW consists of biodegradable and non-biodegradable waste. Non-biodegradable portion is mostly occupied by inert material but also include paper, plastics, glass *etc*., which have either recycling potential.

Therefore, an integrated solution include, proper segregation of the MSW at the source, as promoted in few pockets *i.e*. either at the source (preferable) or at the transfer stations and processing centre, the organic portion can be sent for composting for use as a soil conditioner/bio fertilizer and the inerts after recovery of valued portion (plastic, glass, paper *etc*.) can be sent for landfilling. However, at all the locations, there may not be a demand for the compost material or the acceptability is less, in such situations, the intrinsic energy value of the MSW can be tapped by converting it into boiler chargeable pellets (refuse derived fuel (RDF)). There are also well controlled direct incineration facilities available in developed countries, where the heat is recovered in the form of hot water networking, steam supply to the nearby industries *etc*. As such, when the composting opportunity is limited, one can explore bio-methanation plants, having least power consumption and the degradable portion could be converted into methane, which can then be converted into energy.

While there are number of technological options (refer Figure 3-2), each has its distinct merits and limitations, which guide us to choose appropriate technology for a given local condition.

Despite the best efforts to reduce, reuse and recycle, there will always be residual waste requiring disposal. The alternative treatment and disposal technologies are:

- Recycle/Reuse
- Composting
- Anaerobic digestion / Biomethanation
- Pelletisation / Refuse Derived Fuel (RDF)
- Pyrolysis and Gasification
- Incineration
- Landfills - Sanitary Landfill / Bioreactor landfill / Secured landfill (for inert waste)

Among the various treatment (or waste diversion) and disposal options as mentioned above, MoEF has notified composting (windrow composting, vermi composting), anaerobic digestion, incineration, pelletization and landfill technologies and has given relevant standards for compost quality, leachate disposal, incineration operations and emissions and landfill specifications.

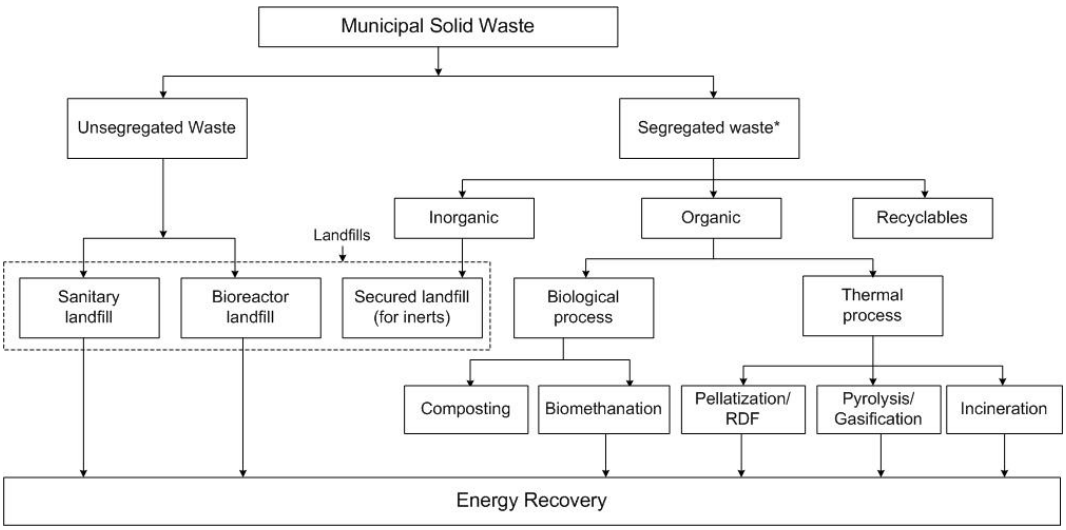

Figure 3-2: Technological Options for MSW Management

*Note: * Segregation could be site/location/area specific (at source, transportation, collection points or at disposal locations)*

3.3.1 Landfill

Landfills are vital components of any well-designed MSW management system. They are ultimate repositories of a city's MSW after all other MSW management options have been exercised. In many cases, landfill is the only MSW management option available after the MSW is collected. The safe and effective operation of landfills depends on sound planning, administration, and management of the entire MSW management system.

As per the Municipal Solid Waste (Management & Handling) Rules, strict measures have been imposed to discourage unscientific land filling/dumping, as these pose problems of:

- Pollution in surface run-off during rainfall and leachate discharges to surface water channels
- Pollution of soil/groundwater/down stream aquifers
- Unhygienic/unsanitary condition in surrounding area

Landfill can be of the following types:

- Sanitary landfill/bioreactor landfill/engineered sanitary landfill – Mixed waste with landfill gas recovery, leachate collection system and storm water management system
- Secured MSW landfill – Inert waste without landfill gas recovery
- Monofills – Only one kind of waste

Over the course of years, landfills have evolved from open dumps to highly engineered facilities designed to isolate waste from the environment. Moisture content which can be optimized with leachate recirculation has been found to be most critical factor affecting MSW biodegradation in landfills.

Within the landfill ecosystems, biological, chemical and physical processes promote the biodegradation of organic wastes in the MSW. The sanitary landfills usually include environmental barriers such as landfill liners and covers, which exclude moisture that is essential to waste biodegradation. Consequently, wastes are contained in a "dry tomb" and remain intact for long periods of time ranging from 30 to 200 years, possibly in excess of life of the landfill barriers and covers. Liner failure could happen in conventional dry landfill sometime in future, which can cause serious groundwater and surface water contamination.

3.3.1.1 Sanitary landfill

Sanitary landfill is the process of dumping of solid waste in a scientifically designed land area spreading waste in thin layers, compacting to the smallest volume and covering with soil on daily basis. Sanitary landfill would be good option for disposal of existing/mixed waste which cannot be segregated. Landfill gas such as methane from the anaerobic conditions prevailing in the landfill due to the presence of organic material in mixed waste can be recovered. The facilities at the sanitary landfill include leachate collection and treatment system, storm water management system avoiding ground and surface water pollution.

The overall approach to the development of any sanitary or engineered landfill is formulated to satisfy the regulatory requirements of MoEF, CPHEEO guidelines and with the objectives of Environmental protection and cost effectiveness. The landfill so designed should be aimed to minimize the following:

- The ingress of water into the landfill
- The production of leachate, its subsequent outflow and uncontrolled dispersions into surrounding aquatic environment
- The accumulation, migration and uncontrolled release of landfill gas into the atmosphere

Landfill design concepts and considerations

- Collection of Baseline data such as temperature, rainfall, population, socio-economic status, terrain features, soil characteristics, geological parameters, ground water table, flood plains, transportation, etc.
- Waste management studies generated within the locality – Waste composition, chemical and physical characteristics, etc.
- Field investigations on handling, collection , transportation and disposal of waste
- Pre-feasibility studies on availability of methane gases from the proposed landfill
- Selection of landfill method based on design life and other baseline factors
  - landfill above ground level, landfill below ground level, slope landfill, valley landfills, combination of slope with others
- Estimates on quantity and quality of leachate generated based on precipitation
- Defining the landfill foot print area based on the quantity/volume of existing and new waste and preparing a layout plan
  - The layout plan may include access roads, Weigh Bridge, leachate collection system, waste processing area, storm water management system, administrative office building, temporary storage and transfer area for waste, drainage facilities, landfill gas collection and management facilities, safety provisions, etc.
- Developing operating methodology – Cell or phase wise operation for progressive use of landfill
- Selection of base liners - it is recommended that for all MSW landfills the following single liner system be adopted as a minimum requirement
- Leachate drainage layer of 30 cm thick made of granular soil having permeability greater than 10-2 cm/sec
  - Protection layer of silty soil of 20 to 30 cm thick
  - Geomembrane of thickness 1.5 mm or more
  - Compacted clay barrier of 1 m thickness having permeability of less than 10-7 cm/sec
- Selection of final covers - vegetative cover, gas venting layer, drainage layer with appropriate thicknesses
- Final cover should be provided a slope of 3 to 5 % for proper surface water drainage.
- Designing leachate collection system including perforated HDPE pipes, drainage layer, leachate collection sumps, leachate trenches, located with appropriate slopes to maximize the leachate flow in the pipes
  - Leachate drainage layer is usually 30 cm thick with slope of 2% or higher
  - The pipe spacing is governed by the requirement that the leachate head should not be greater than drainage layer thickness
  - Design of wells/side slopes risers for leachate removal
  - Design of holding tank
  - Estimating size of pipes, sumps and pumps
  - Deciding the leachate management option – leachate discharge to waste water treatment system, recirculation within the landfill for faster decomposition of biodegradable waste, evaporation of leachate, treatment of leachate based on its characteristics,

- Landfill gas collection and management system with a safe gas venting system to collect the gas consisting of HDPE pipes. The gas control system involves the following features
  - A containment system which encloses the gas within the site and prevents migration outside the landfill
  - A system (passive or active) for collecting and removing landfill gas from within the landfill and in particular from the perimeter of the landfill
  - A system for flaring or utilizing the collected gas with adequate back up facilities
  - Gas vents will be placed 30 to 75 m on the landfill cover and level of methane will be monitored regularly.
- Designing storm water management system for the maximum rainfall intensity to avoid surface water pollution and include storm water ponds, swales, etc based the annual rainfall, slope of the area,
- Stability of the landfill - stability analysis shall be conducted for the following cases
  - Stability of excavated slopes
  - Stability of liner system along excavated slopes
  - Stability of temporary waste slopes constructed to their full height
  - Stability of slopes of above ground portion of completed landfills
  - Stability of cover systems in above ground landfills
- Equipments for landfill site operations – Weigh bridge, tipper, Compactor, JCB, etc. their number would depend on the quantity of waste to be handled.
- Site infrastructure – Administrative office, store room, Parking area, Weigh Bridge, access roads, waste segregation area, vehicle cleaning area, waste inspection and transfer, site fencing, green belt, lighting, etc.
- Environmental monitoring plan to ensure optimal performance of the landfill – Monitoring of environmental parameters like – surface water quality, ground water quality, leachate quality, ambient air quality during the active and post closure period.
- Location criteria for Landfills as per CPHEEO/MSW guidelines
  - No landfill within 200 m of a lake or pond
  - No landfill within 100 m from river
  - No landfill within flood prone areas
  - No landfill within 200m of right of way of any state or National Highway.
  - No landfill within 500 m from a notified habitant area.
  - No landfill within 300 m of public park
  - No landfills within wetlands
  - No landfill within 20 km of an airport or airbase.
  - No landfill in a coastal regulation zone
  - No landfill in potentially unstable zones
  - Landfill should have a buffer zone around it up to a distance prescribed by the regulatory agencies.
  - Exclude the areas with unstable geological features such as weak soils (organic soils or soft clay or clay-sand mixtures or soils that lose strength with compaction or with wetting, *etc*.)
  - Exclude the areas with high population, unique archaeological, historical, paleontogical and religious interests
  - Exclude areas of ground water recharge and extremely high water table zone
  - Exclude areas prone to natural hazards (such as volcanic activity, seismic disturbance and landslides)

- Exclude areas with subsidence (such as owing to subsurface mines; water, oil or gas withdrawal; or solution-prone subsurface)
- Exclude agricultural/forest areas

In exceptional cases, the committee may consider certain sites if it has reasons to believe that the proposed mitigation measures can ensure anticipated impacts within the acceptable limits.

3.3.1.2 Bioreactor landfill

Today, the "bioreactor landfill" is one idea that has gained significant attention. A bioreactor landfill is a sanitary landfill that uses enhanced microbiological processes to transform and stabilize the readily and moderately decomposable organic waste constituents within 5 to 10 years of bioreactor process implementation. The bioreactor landfill significantly increases the extent of organic waste decomposition, conversion rates and process effectiveness over what would otherwise occur within the landfill. The "bioreactor landfill" provides control and process optimization, primarily through the addition of leachate or other liquid amendments, the addition of sewage sludge or other amendments, temperature control, and nutrient supplementation. Beyond that, bioreactor landfill operation may involve the addition of air. Based on waste biodegradation mechanisms, different kinds of "bioreactor landfills" including anaerobic bioreactors, aerobic bioreactors, and aerobic-anaerobic (hybrid) bioreactors have been constructed and operated worldwide.

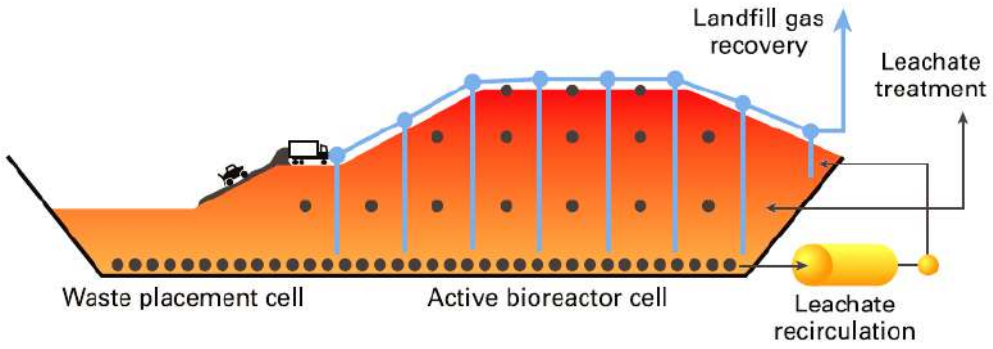

Figure 3-3: Schematic Diagram of Bioreactor Landfill

Aerobic landfill processes are analogous to wet composting operations in which biodegradable materials are rapidly biodegraded using air, moisture, and increased temperatures created by biodegradation. First liquid is pumped under pressure into the waste mass through injection wells in order to maintain moisture content between 50% and 70% by weight. Once optimal moisture conditions have been reached, air injection commences. Blowers typically are used to force air into the waste mass through a network of perforated wells that have been installed in the landfill. The rates of injection of air and leachate into the landfill are similar to the air and moisture application rates used in many composting systems. The aerobic process continues until most of the easily and moderately degradable compounds have been degraded and the compost temperature gradually decreases during the final phase of "curing" or maturation of the remaining organic matter.

Aerobic bioreactor landfills are operationally more intense than anaerobic bioreactor landfills; however, post closure costs would be substantially lower due to reductions in LFG generation and cover settlement.

Anaerobic bioreactor landfills tend to stabilize the landfilled waste rapidly by the addition of moisture (through recirculation of leachate to uniformly wet the waste mass. Landfill degradation of MSW frequently is rate-limited by insufficient moisture. The maximum methane production in landfills occurs at moisture content of 60-80% wet weight, for which reason, most landfills are well below the optimum moisture content for methane production. In addition, the liquid absorptive capacity of the waste, in general, is about 16-29% or about 150-300 litres/m^3 of waste which represents a large potential capacity for leachate storage.

Leachate can be injected into the waste via horizontal trenches, vertical wells, surface infiltration ponds, spraying, and prewetting of waste. Anaerobic bioreactor landfills initially should be carefully monitored. If the waste is wetted too rapidly, a buildup of volatile organic acids might lower the leachate pH, inhibiting the methane-producing bacteria population and reducing the rate of biodegradation. Leachate parameters (such as pH, volatile organic acids, and alkalinity) and LFG parameters (such as methane content) are direct indicators of an established methane-producing bacteria population. Optimal conditions for methane-producing bacteria are a pH of greater than 6.5. A high volatile organic acids-to-alkalinity ratio (>0.25) indicates that the leachate might have a low buffering capacity and conditions could soon inhibit methane generation.

The gas content of anaerobic bioreactors is similar to that of conventional landfills, with methane and carbon dioxide each making up approximately 50% of the total LFG volume. When the methane content of the LFG exceeds approximately 40%, the methane-producing bacteria population can be considered established. A decrease in the methane gas content below 40% is a possible indication that the waste is becoming too wet or dry. Once the methane-producing bacteria population has become established, the rate of leachate recirculation may be increased.

Bioreactor landfills are receiving a great deal of attention from environmental professionals because they offer a sustainable way to achieve increased waste degradation along with benefits such as reductions in post-closure management. As a result of a reduced period for landfill leachate and improvement potential for more rapid land reuse for a recreational facility or industrial park and high volumes of gas is generated which can be recovered as a potential source of energy. Bioreactor landfills have advantages over traditional landfills. They reduce the cost of removing and disposing leachate, which is used on site. Anaerobic bioreactors begin producing methane much more quickly than landfills designed to inhibit degradation. Bioreactors also gain space as the waste degrades, meaning more waste can be added.

Table 3-1: Typical Constituents of Municipal Landfill Gas

Constituent	Range (Percentage or Concentration)
Major Constituents	
Methane	30 to 60 %
Carbon Dioxide	34 to 60 %
Nitrogen	1 to 21 %
Oxygen	0.1 to 2 %
Hydrogen Sulphide	0 to 1 %

Constituent	Range (Percentage or Concentration)
Major Constituents	
Carbon Monoxide	0 to 0.2 %
Hydrogen	0 to 0.2 %
Ammonia	0.1 to 1 %
Trace Constituents	
Acetone	0 to 240 ppm
Benzene	0 to 39 ppm
Vinyl Chloride	0 to 44 ppm
Toluene	8 to 280 ppm
Chloroform	0 to 12 ppm
Dichloromethane	1 to 620 ppm
Diethylene Chloride	0 to 20 ppm
Vinyl Acetate	0 to 240 ppm
Trichloroethane	0 to 13 ppm
Perchloroethane	0 to 19 ppm
Others	Variable

Source: CPHEEO Manual

3.3.1.3 Secured MSW landfill for inerts

A secured landfill is a carefully engineered depression in the ground (or built on top of the ground) into which wastes are dumped to avoid pollution to the surrounding environment. Secured MSW landfill should be restricted to non-biodegradable, inert waste and other waste not suitable for recycling or for biological processing.

The important features that should be considered before designing a landfill are given in Schedule III - "Specifications for Landfill sites" of MSW rules 2000 (refer **Annexure III**). These include:

- Site Selection
- Facilities at the site
- Specifications for land filling
- Pollution prevention
- Water quality monitoring
- Plantation at landfill site
- Closure of landfill site and post care
- Special provisions for hilly areas

3.3.2 Composting

Composting is an organic method of producing compost manure by decomposition and stabilization of organic matter. Composting process (Figure 3-4) is commonly used method and results in the production of stable compost product reduced in size (when compared to initial size) and free from offensive odors. Compost is particularly useful as organic manure which contains plant nutrients (nitrogen, phosphorous and potassium) as well as micro nutrients which can be utilized for the growth of plants. Composting can be carried out in two ways - aerobically (with the presence of oxygen) or anaerobically

(without the presence of oxygen) or vermi-composting or by any other biological mechanism.

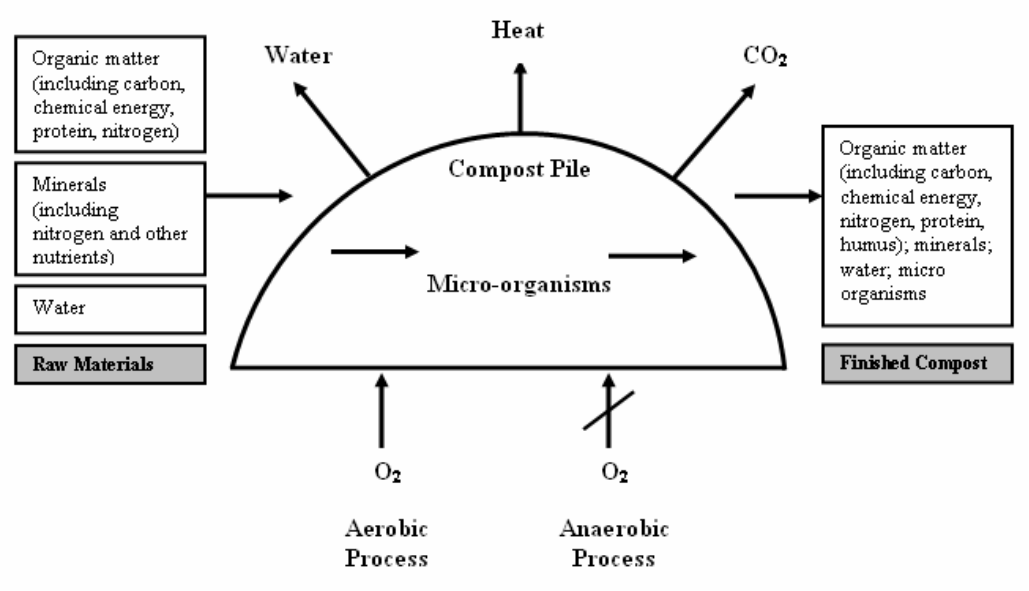

Figure 3-4: Schematic of Composting Process

By controlling some of the composting influencing factors, natural composting process could be accelerated. These influencing factors also have impact on quality of compost produced. Some of the important factors in the composting process are temperature, C/N ratio, phosphorous, sulphur, moisture, particle size, oxygen flow, *etc*.

- Temperature: Optimum temperature for aerobic composting - 70ºC. High temperature results in increase rate of biological activity and faster stabilization of the material. Very high temperature results Nitrogen loss. High temperatures ensure destruction of pathogens and parasites.
- C/N ratio: Optimum ratio is 30. To bring down the ratio sewage and sludge will be added. To increase the ratio straw, sawdust, paper will be added.
- Phosphorous: One of the essential nutrients for plant growth and determines the quality of compost. Phosphorous concentration might increase as composting proceeds.
- Sulphur: Presence of Sulphur in sufficient quantities can lead to the production of volatile, odorous compounds. The major sources of Sulphur are two amino acids (cysteine and methionine). Under well-aerated conditions, the sulfides are oxidized to sulfates, but under anaerobic conditions, they are converted to volatile organic sulfides or to H_2S, leading to a bad odor. Some compounds like carbon disulfide, carbonyl sulfide, methyl mercaptum, diethyl sulfide, dimethyl sulfide, and dimethyl disulfide might also lead to bad odors.
- Moisture: Optimum 50 to 60%, very high moisture content will result anaerobic condition. Higher moisture content is essential for mechanical operated system and the waste contains high percentage of fibrous material.
- Oxygen and aeration: In case of aerobic process, helps to decompose the organic matter at a faster rate. However, care must be taken not to provide more oxygen which might dry the system and slow down the composting process.

- Particle size: Smaller particles produce homogenous particle size which helps to maintain optimum temperatures. But too fine particle may not allow air to flow into the piles.

High quality compost would have the following physical and chemical properties.

Table 3-2: Physical and Chemical Properties of High Quality Compost

Property	Values
Physical Properties	
Density	500-800 g/L
Water content	30-45%
Granulation size	fine grained 4-12m, coarse grained 12-40 mm
Low content of foreign substances and stones	Foreign substances < 0.5% stones < 5%
Chemical Properties	
Nutrient content should be within the following values (% TS / % Dry Matter)	N: 0.5 to 1.8 P_2O_5: 0.4 to 1.0 K_2O: 0.6 to 1.8 MgO: 0.7 to 3.0 CaO: 3.0 to 12.0
Salinity	1.0-8.0 g kCl/L
pH	7 – 8
Content of organic matter	Measured as ignition loss - 20-50% Matured compost - 20% organic matter Raw compost - >40% organic matter
Low content of heavy metals	Lead : 50 to 100 Cadmium: 0.1 to 1.0 Chrome: 26 to 60 Copper: 30 to 50 Nickel: 10 to 30 Mercury: 0.1 to 0.5 Zinc: 150 to 350

There are various methods of composting and the approach in selecting the appropriate method of composting depends on time to complete composting, the material and volume to be decomposed, space available, the availability of resources (labour, finances, etc.) and the quality of finished product required. In general composting process consists of four decomposition phases when a suitable environment is provided:

- Mesophilic phase (I): In this phase slightly rotted material exists, in which mainly bacterial degradation of easily degradable substances takes place. The temperature rises up to 42^{o}C.
- Thermophilic phase (II): In this phase fresh compost is produced where further degradation of easily degradable materials as well as degradation of cellulose, caused by thermophilic fungi and bacteria. The temperature in this phase rises up to 65^{o}C which causes self limitation or decrease in reproduction of micro organisms.

- Cooling phase (III): Finished compost is produced in this phase, where degradation of cellulose by fungi and bacteria, and formation of humus substances takes place. A decrease in microbial activity and temperature occur in this phase.
- Maturing phase (IV): Matured compost is produced in this phase, with further decrease of temperature to the surrounding temperature. Very low microbial activity with further formation of humus substances and stabilization take place.

3.3.2.1 Aerobic composting

In aerobic process, aerobic micro-organisms oxidize organic compounds to carbon-dioxide, nitrite and nitrate. This carbon is used as a source of energy while nitrogen is recycled (high nitrogen waste will grow bacteria). Due to this exothermic reaction the temperature of the mass rises and thus the organic waste will break down quickly and is free from odour. Aerobic process needs high maintenance in monitoring air, moisture and high temperatures in the system. Some of the basic aerobic composting techniques are indore composting, windrow composting, vermi composting, in-vessel composting, *etc*. Aerobic composting of MSW is commonly carried out in windrows.

i. Indore method

In this method composting is done in pits which involves filling of alternate layers of MSW and night soil. The pit will be completely filled and a final soil layer is laid to prevent fly breeding, entry of rain water and for conservation of released energy. However, to ensure aerobic condition the material is turned at specific intervals for which a 60 cm strip on the longitudinal side of the pit is kept vacant. For starting the turning operation, the first turn is manually given using long handled rakes 4 to 7 days after filling. The second turn is given after 5 to 10 more days. Further turning is normally not required and the compost is ready in 2 to 4 weeks. This method stabilizes the material in shorter time and needs lesser space. As no odorous gases are generated in this process, it is environment friendly & hence commonly preferred. While the organic matter is stabilized during the composting process, the moisture content also changes. The non decomposable materials are rejected. Hence the quantity of compost is much lesser than the input and is normally around 50% and the exact value depends upon the characteristics of the input material.

ii. Windrow composting

Windrow composting is widely used in India at a large scale as the climatic condition is arid. Therefore, in areas where higher ambient temperatures are available, composting in open triangular or trapezoidal windrows is to be preferred. Windrow composting is the process of decomposing organic materials to form stabilized organic matter. It is defined as the controlled, heat dependent, microbiological process of decomposing organic materials into a biologically stable, humus-rich material. Compost is used in agriculture, horticulture, home gardening, land reclamation, wetland mitigation, and erosion prevention to help rebuild soil organic matter and to provide a good medium for plant growth. The major obstacles to this technology is the limited markets for compost used and environmental concerns about industrial or toxic wastes that may enter the waste stream and end up in the compost.

Windrow area should be with an impermeable base made from concrete of compacted clay of 40 to 50 cm thick. The permeability co-efficient should be less than 10(-7) cm/sec. A slope of 1-2 % should be maintained in the base. The base should be circled with a

lined drain for collection of leachate or surface runoff. Windrow composting is a two phase process.

Phase I: Rotting

- This phase starts with transferring the mechanically treated waste to a specific area designed especially for windrows. A coarse material such as wood chips is spread over that area to enhance ventilation and drainage at the bottom of the windrow, and to prevent saturation that might cause anaerobic conditions.
- Triangular or trapezoidal windrows are made parallel to each other with enough distance in between. The length and the number of windrows would depend on the quantity of organic waste that the plant is receiving. However, the following dimensions shall be maintained.
  - Length of windrow = 100 - 130 m
  - Width of windrow = 3 m (base)
  - Height of windrow = 1.5 m
- Turning of waste and addition of water by special machine to provide the oxygen and water necessary for aerobic decomposition. Air can be pumped into the waste for good ventilation (forced aeration). The waste remains in windrows for 12 weeks to decompose with turning and addition of water twice a week during the first three weeks and once a week for the remaining period. Windrows should be covered with special cover to prevent evaporation but without preventing air intrusion.

Phase II: Rotting

- In this phase, the fresh compost produced in the first phase is transferred to another area and piled up and kept to mature for a period of four weeks, without turning and water addition. Matured and dry compost (water content = 25 - 30%) is produced.
- The matured compost is separated into two fractions, fine and coarse by sieving. The fine fraction is packed in suitable quantities according to it purpose of used. The coarse fraction is sold without packaging.

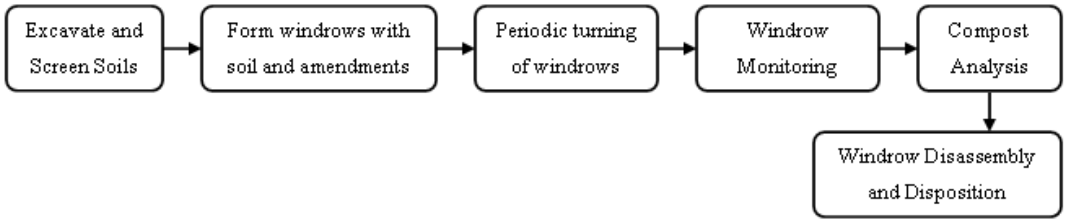

Figure 3-5: Steps in Composting

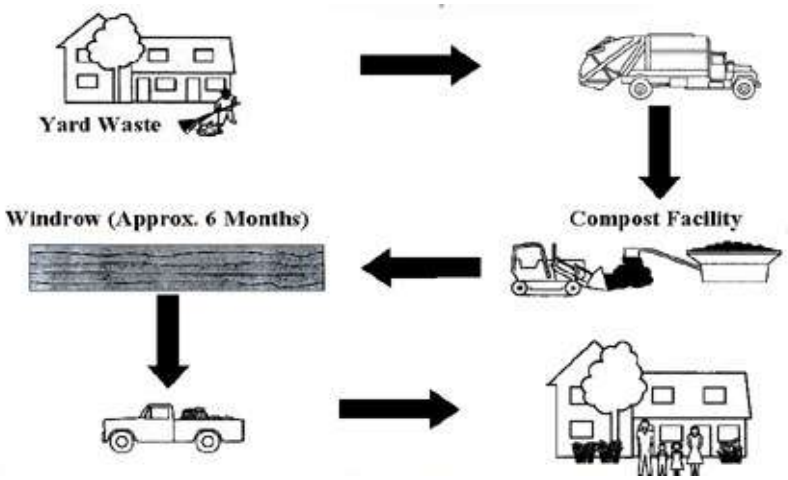

Figure 3-6: Composting Procedure

iii. Vermi-composting

In vermi-composting, the aerobic decomposition of organic matter is by using micro-organisms. It is the use of selected species of earthworms to help decompose and transform organic wastes into useful compost. In this method, earthworms play important role in fragmenting, mixing and aerating the waste. There are various methods of vermi-composting, making it impossible to present a definitive guide to best practice.

Vermi-composting is carried out at relatively low temperatures (under 25°C), compared with composting, where pile temperatures can exceed 70°C. With vermi-composting it is vitally important to keep low temperature; otherwise the earthworms will be killed. It is the joint action between earthworms and the aerobic microorganisms that thrive in these lower temperatures (mesophilic) that breaks down the waste. Hence it is common with vermi-composting systems to apply waste frequently in thin layers, a few centimeters thick, to beds or boxes containing earthworms in order to prevent overheating and to help keep the waste aerobic. It is difficult to directly compare composting with vermi-composting in terms of the time taken to produce stable and mature compost products. With vermi-composting, particles of waste spend only a few hours inside the earthworm's gut and most of the decomposition is actually carried out by microorganisms either before or after passing through the earthworm. Hence, earthworms accelerate waste decomposition rather than being the direct agent.

With in-vessel and windrow composting it usually takes at least six to twelve weeks to produce stable compost and research suggests that vermi-composting takes around the same time. However, processing rates crucially depend on many factors such as the system being used, the processing temperature and other factors, the nature of the wastes and the ratio of earthworms to waste.

One advantage that vermi-composting has over other composting procedures is that a net excess of earthworms can be produced and these may be harvested for a variety of purposes. It should be noted that it can take many months or even years to build up a large working population of earthworms capable of vermi-composting significant quantities of waste. Vermi-composting does have one serious disadvantage and this relates to the destruction of human and plant pathogens that can be present in some wastes. Destruction of most pathogens is more easily achieved in windrow composting due to the high operating temperatures and the intense microbial reactions taking place. Although the

destruction of human pathogens has also been shown to be very effective with vermi-composting, elimination of pathogens requires very effective management of the vermi-composting process. It is often recommended that wastes, such as sewage sludge, which are known to contain human pathogens, are either pre-composted before vermi-composting or else the resulting casts should be sterilized before use.

Scientific and technical aspects of vermi-composting

A number of factors affect the life cycle of earthworms and hence determine the rate of waste processing, vermi-compost output and the number of earthworms that are produced. In particular, temperature, moisture, waste characteristics and earthworm density are all important. There is little doubt that maintaining vermi-composting systems at a constant temperature of around 20°C would give maximum vermi-compost output and ensure maximum earthworm growth and reproduction. In Indian conditions, if vermi-composting is carried out they are likely to produce significantly lower higher than for beds operating under optimum conditions.

Earthworms prefer material that is fairly damp, in the range 70-90% moisture. Hence there is usually more of a need to add more moisture to the waste material before and during vermi-composting compared with traditional composting. Since moisture is not driven off by high temperatures, as with composting, the finished vermi-compost can be quite moist, and often the conversion of waste to vermi-compost results in only a small weight loss, typically around 10%.

Earthworms will process more waste and will grow and reproduce more quickly when fed with some wastes. Sewage sludge, animal manures, paper pulps, processed food slurries, brewery waste, mixed household waste, garden and vegetable wastes and many other biodegradable materials have been used on a large scale to produce vermi-compost and to breed earthworms. Vermi-composting is similar to traditional composting in the sense that materials with carbon to nitrogen (C: N) ratios in the range 15 – 35:1 are considered to be suitable. In general, fresh, finely shredded organic materials which, decompose easily will sustain the greatest numbers and diversity of microorganisms and this in turn will result in rapid decomposition and produce the highest earthworm growth and reproduction. The density of earthworms in any vermi-composting system is related to the rate of waste processing and if vermi-compost production is the main aim then it is advisable to maintain a high density of mature earthworms. However, high earthworm densities will eventually reduce the number of earthworms produced, by regulating growth and reproduction. Hence, if the main aim is to produce a net surplus of earthworms, comparatively low densities of immature earthworms should be used. Equally, regular harvesting of earthworms and cocoons should be carried out to maintain this low density at all times.

iv. Rapid composting methods

Traditional composting methods take as long as 4 to 8 months to produce finished compost, while rapid composting process offer possibilities for reducing the processing period up to three weeks. A variety of approaches and their combinations have been used to hasten the composting process, which include active windrows, passive windrows, aerated static windrow, in-vessel composting, vermin-composting, *etc*. Most of these methods are based on aerobic process.

(a) Active windrows

Organic waste is placed in long windrows and turned manually or mechanically by front end loaders or turners. The optimum height and width of the windrows depends on the type of equipment used to turn them. The mechanical equipment is so selected to compact the composting material and results in less composting periods and good consistent quality product. Frequency of turning can be determined by knowing the temperature within the windrows.

(b) Passive windrows

Compost in windrows is produced by natural aeration over long periods of time. Porosity of the initial mix, uniform product mixing and particle size greatly improve the speed of the process and product quality. This method eliminates the need for turning by supplying air to the composting materials through perforated pipes (with pipe ends open) embedded in each windrow. Air flows into the pipes and through the windrow because of the chimney effect created as the hot gases rise upward out of the windrow. The windrow should be well insulated with covering material. As the composting material is not turned after the windrows are formed, they must be thoroughly mixed before they are placed in the windrow. During construction of windrow, compaction should be avoided while mixing of materials. Aeration pipes are placed on top of the compost base. When the composting period is completed, the pipes are simply pulled out, and the base material is mixed with the compost.

(c) Aerated static windrows

Compost is produced in windrows with mechanical aeration and air is supplied through perforated plastic pipes, aeration cones or a perforated floor. Aeration is accomplished either by forcing or drawing air through the compost pile. Aeration systems can be relatively simple using electrical motors, fans and ducting, or they can be more sophisticated incorporating various sensors and alarms. This system of aeration requires electricity at the site and appropriate ventilation fans, ducts and monitoring equipment. The monitoring equipment determines the timing, duration and direction of airflow. The pile should be placed after the floors are first covered with a layer of a bulking agent, such as wood chips or finished compost. The material to be composted is then added and a topping layer of finished compost applied to provide insulation.

(d) In-vessel composting

In-vessel composting refers to a group of methods which confine the composting materials within a building, container, or vessel. In-vessel methods rely on a variety of forced aeration and mechanical turning techniques to speed up the composting process. There are a variety of in-vessel methods with different combinations of vessels, aeration devices, and turning mechanisms. Some of the in-vessel methods are bin/box, channels, rotating drums, *etc*.

Aeration of the material is accomplished by continuous agitation using aerating machines which operate in concrete bays or by fans providing air flow from ducts built into concrete floors. The main advantages of the in-vessel system over other methods are; more efficient composting process and a decreased number of pathogens resulting in a safer and more valuable end product. In-vessel composting can maintain a rapid decomposition process year-round regardless of external ambient conditions.

Disadvantages of the enclosed vessel method include high capital and operational costs due to the use of computerized equipment and skilled labour. In-vessel composters are generally more automated than active or static pile systems and can produce a top quality finished product on a consistent basis.

3.3.2.2 Anaerobic composting

Anaerobic composting is also called anaerobic digestion or bio-gasification. This technology is the biological conversion of biodegradable organic materials in the absence of oxygen at temperatures lower than 93°C. Therefore very slow working bacteria will be growing which does not require any air and the compost may take long period to break down. This breakdown process is carried out by anaerobic micro organisms that convert carbon-containing compounds to a biogas (primarily methane and carbon dioxide). A very small quantity of energy is released during this process and the temperature of the composting mass does not raise much. This is a reduction process and final product is subjected to minor oxidation when applied on land. The residue is a stabilized organic material that can be used as a soil amendment. Anaerobic composts may have awful smell. Anaerobic digestion is suitable for the bio-degradables, including food wastes, yard waste, animal wastes, and some paper fibers. Bangalore method is an example of anaerobic composting

Bangalore Method

This is an anaerobic method conventionally carried out in pits. Formerly the waste was anaerobically stabilized in pits where alternate layers of MSW and night soil were laid. The pit is completely filled and a final soil layer is laid to prevent fly breeding, entry of rain water into the pit and for conservation of the released energy. The material is allowed to decompose for 4 to 6 months after which the stabilized material is taken out and used as compost. The Bangalore method requires longer time for stabilization of the material and hence needs larger land space. The gases generated in this anaerobic process also pose smell & odour problems.

3.3.3 Biomethanation / anaerobic digestion

Biomethanation of MSW in India is gaining importance at a considerable amount, but only a few local government bodies could initiate this technology, as the capital investment is very high for the biomethanation plant. Biomethanation is the process of conversion of organic matter in the waste (liquid or solid) to biomethane (sometimes referred to as “biogas”) and manure by microbial action in the absence of air, known as “anaerobic digestion”.

The solid waste and the slaughterhouse waste is first mixed with raw sewage and conveyed to the primary digester. Effluent from the primary digester is sent to the secondary digester after stabilization. The raw gas generated from the primary and the secondary digester is then sent to the gas balloons for storage purpose. The excess effluent from the secondary digester will be re-circulated back to the primary digester for further generation of gas. The gas thus stored in the gas balloon is passed through a scrubber where gases like H_2S and SO_2 and moisture are removed from the gas. This clean gas is conveyed under pressure to the Power Generating Engine to produce power supply. The excess sludge from the secondary digester is conveyed to the centrifuge to separate the liquid and solids for further disposal.

Production of Methane from MSW by this process involves three basic steps:

- First step involves preparation of organic fraction of MSW, which includes receiving, sorting, separation and size reduction.
- Second step involves addition of moisture & nutrients (*e.g.*, sewage sludge), blending, pH adjustment to about 6.7, heating of the slurry to between 55 to 60^{o}C, and anaerobic digestion in a reactor with continuous flow, in which the contents are well mixed for a period of time varying from 5 to 10 days.
- Third step involves capture, storage and if necessary, separation of gas components evolved during digestion process.

3.3.4 Pelletization and refuse derived fuel

Pellets are formed from the combustible portion of MSW. Pelletization initially involves segregation of waste into high and low calorific value materials and then shredded and compacted into pellets with the required bulk density and later can be dried to get the appropriate heat value. These pellets so produced have a calorific value of 4000 Kcal/kg of the product which is quite close to that of coal and therefore is a good substitute for coal, wood, *etc*. to RDF plant. Comparatively, pellets have advantages over coal and are clean, energy efficient, eco-friendly fuel for coal based industries, power generating industries. Additional advantage of Pellets is easy storage and transportation.

RDF can be produced from MSW through a sequence of processes consisting of:

- Separation at source
- Sorting or mechanical separation
- Size reduction (shredding, chipping and milling)
- Blending
- Drying and pelletizing
- Packaging
- Storage

The MSW is initially dried to reduce its moisture content. It is then screened to remove inerts such as sand, silt and soil. It is then processed to remove and separate incombustible materials such as glass, metal and other contraries and wet organic matter such as garden and food waste containing high moisture and high ash material. Sometimes the waste is further subjected to air separation and then shredded. The reduced size material can be directly used in boilers on site. If the material is to be used offsite, it is usually densified into pellets and then transported to the place where it is to be used. RDF can be burned for fuel by itself or co-fired with other fuels.

Previously, few RDF plants were setup with coal fired boilers when RDF was used along with coal but now due to strict emission standards it is burnt in dedicated boilers designed and built specifically for RDF.

Some of the options of using RDF from MSW to energy include:

- Co-combustion in coal fired boilers
- Co-incineration in cement kilns
- Co-gasification with coal or biomass

3.3.5 Incineration

Incineration is a process of controlled combustion for burning of wastes and residue containing combustible material. Carbon-dioxide, water vapor, ash and non-combustible materials are end products. The heat generated during incineration is recovered and utilized for production of steam, heating water and generating electricity. Incineration is highly exothermic. Incineration is used to achieve maximum volume reduction of solid waste and when there is shortage of landfilling facilities.

The emissions from incineration of solid waste are of health concern; however it is not practiced frequently in developing countries. Incineration being a notified technology in the Ministry, as per MoEF MSW rules 2000, incinerators shall meet the operating and emission standards as listed in Table 3.3. In order to achieve the emission standards suitably designed pollution control devices shall be installed or retrofitted with the incinerator. It is also to be noted that chlorinated plastics shall not be taken for incineration and also low sulphur fuel or diesel shall be used as fuel in the incinerator.

Table 3-3: Operating and Emission Standards for Incinerators

Operating Standards	
Combustion Efficiency	At least 99%
Computation of Combustion Efficiency	C.E = (%CO_2 x 100) / (%CO_2 + %CO)
Emission Standards	
Parameters	Concentration mg/Nm^3 at (12% CO_2 Correction)
Particulate Matter	150 mg/Nm^3
Nitrogen Oxides	450 mg/Nm^3
HCl	50 mg/Nm^3
Minimum stack height above the ground	30m
Volatile Organic Compounds in ash	Not > 0.01%

Figure 3-7: Cross Section of a Mass Burn Incineration Plant

Source: Cardiff University, Waste Research Station

Note: 1. Waste holding area/pit; 2. Grab; 3. Feed hoppers; 4. Moving grate; 5. Hydraulic arm to push the waste; 6. Air holding chamber; 7. Ash quenching; 8. Boiler; 9. Flue gas cleaning system; 10. Flue gas cleaning system; 11. Stack.

It is unlikely that specialized high temperature incineration or waste to energy plant would be economic for the small refuse volumes. More basic methods of incineration such as pit incinerators may be appropriate for burning selected waste materials in order to reduce volumes to landfill.

3.3.6 Pyrolysis and Gasification

Pyrolysis

MSW is initially shredded, screened and separated from incombustible matter before using in Pyrolysis process. Pyrolysis is a thermal process where organic materials present in the waste are broken down under pressure and at temperatures greater than 925°F in the absence of oxygen to become gas comprising smaller molecules (Syngas). Along with syngas, char and oil are also produced. The gases produced comprise carbon monoxide (25%), hydrogen and hydrocarbons (15%) and carbon dioxide and nitrogen (60%). Then, syngas is cleaned and burned in internal combustion (IC) engine generator sets or turbines to produce electricity.

The syngas produced can be utilized in boilers, gas turbines, or internal-combustion engines to generate electricity or be further processed into organic chemicals.

Thermal cracking and condensation reactions produce gaseous, liquid and solid fractions. Three major component fractions resulting from Pyrolysis are:

- Gas Stream - Syngas comprising of H_2, CH_4, CO,
- Tar and/or oil stream - liquid at room temperature containing chemicals such as acetic acid, acetone and methanol
- A char consists of almost pure Carbon plus any inert material that may have entered the process.

NEERI studies reveal that out of the heat contained in the waste, 67 -75% is recovered. However, when the heat recovered is compared to that provided as input, there is a heat loss due to endothermic nature of reaction. Table 3-4 provides the results of one such a typical study.

Table 3-4: Case Study – Pyrolysis of Indian MSW

Input		
1	Heat energy in 1 kg dry MSW	2775 kcal/kg
2	External electrical energy - 4300 kcal. 20% heat losses: Net heat transferred - 0.8 x 4300	3440 kcal/kg
	Total	6215 kcal/kg
Output		
1	0.35 kg Char + 0.25 kg Oil + 0.30 kg Gas + 0.10 kg water	= Total
2	(2100 kcal) + (2000 kcal)+ (1200 kcal)	= 5300 kcal
3	Net heat loss (Endothermic Effect) = 6215 - 5300	= 0915 kcal

4	So, 915 X 100 / 6215 = 91500 / 6215	= 14.8% of input
5	Energy recovery = Heat Value of product - external heat input (5300 kcal - 3440 kcal)from an input of 2775 kcal from MSW	1860
6	% recovery of energy = 1860/2775	67%

The proportion of these constituents changes with the rate of heating, maximum temperature and retention at maximum temperature. It is known that the high temperature pyrolysis yields a larger proportion of gas and lesser proportion of liquids.

In developed countries, paper, plastics *etc*. form more than 50% of the waste resulting in a large proportion of gaseous as well as liquid products which have a heating value and can be easily used. However, the Indian MSW has a low projection of paper, plastics, *etc*. and hence its successful adoption is difficult. In developed countries a substantial proportion of the total cost is often spent on processing. Unfortunately, more than 80% of the total cost of MSW Management in India is spent on collection and transportation, and the expenditure on processing is meager.

Gasification

Gasification is the partial combustion of organic matter in the presence of restricted quantity of oxygen or air at high temperatures (than Pyrolysis). The gas so produced is producer gas. The producer gas is cleaned and burned in internal combustion (IC) engine generator sets or turbines to produce electricity.

The processes are carried out at a temperature between 500°C -1000°C to produce three component streams:

- Gas - Producer gas which is a mixture of combustible gases such as H_2, CO, CO_2 and CH_4 and some hydrocarbons
- Liquid - It contains tar, pitch, light oil and low boiling organic chemicals like acetic acid, acetone, methanol *etc*.
- Char - It consists of elemental carbon along with the inert materials in the incoming waste.

3.3.7 Recycling/reuse

Recycling refers to the collection, separation, processing, or use of materials that would otherwise become solid waste. The activities included under the term recycling are numerous, including the initial collection of materials; marketing those raw materials; producing products from those materials; and use of those products in the marketplace. Some of the materials from MSW that would be recycled are plastics, metals, paper, glass, rubber, rags, leather, etc. the recovery of the materials will reduce the need to use natural resources directly and may reduce emissions from extraction and processing of raw materials. On the other hand, there could be environmental or health effects from reprocessing materials which have been taken out of the waste stream. These could offset the benefits of recycling to some extent.

3.3.8 Comparative analysis of technologies

A comparative analysis of the available technologies is summarized in Table 3-5.

Table 3-5: Comparative Analysis of the Available Energy Technologies

Item	Composting	Sanitary/ Bioreactor Landfill	Bio-Methanation	Incineration	Pelletisation	Pyrolysis
Requirement for segregation	Very high	Low	Very High	Low	High	High
Potential for Direct Energy Recovery	No	Moderate	No	Yes	No	Yes
Overall efficiency in case of a small set up	High	Low	High	Low	Low	Moderate
Efficiency in case of high moisture	High	Moderate to High	High	Very low	low	Low
Land requirement	High	Moderate in case of bioreactor landfill because, at least in theory, the landfilled material can be removed once the contamination potential from the landfill is negligible and same site can be reused.	Low to Moderate	Low	Low	Moderate
Ability to tackle bio-medical and low-hazard waste	No	No	No	Yes	No	Yes (to some extent)
Concerns for toxicity of product	-	Low	-	High	-	-
Leachate Pollution	High, if not routed properly	Moderate to high depending	Moderate to high in case effluent is not properly	None	None	None

	for treatment	upon the leachate recycling and control systems	treated or utilized			
Concern for Atmospheric Pollution	Moderate	Low	Low	High (not easy to control)	Moderate	Moderate (easy to control)
Capital Investment	High	High	High	High	Moderate	unknown

Table 3-6: Influencing Parameters and Constraints of Various MSW Technologies

Technology	Influencing Parameters	Limitations	Benefits	Environmental Concerns
Composting	▪ Segregation of organics from MSW ▪ Quantity of organic matter ▪ Moisture content ▪ Market demand ▪ Location of the facility	▪ Receiving of unsegregated waste ▪ No yield consistency (varying compsot quality) ▪ Slow process ▪ Sound marketing arrangements are required ▪ Sensitive process – requires good segregation and maintenance ▪ Limited acceptance by the farmers and sometimes even by the city parks and gardens department	▪ Reduces volume of organic waste fraction of MSW by 50 to 75 % ▪ Stabilizes organic fraction of MSW ▪ Potential usable product as output ▪ Potential of co-composting operations with other waste streams ▪ Reduces organic waste to landfill thereby reducing the production of leachate and gases from landfill ▪ Highly useful product for crop improvement ▪ Value addition to waste resource ▪ Sustainable approach	▪ The final product which is used as manure in fields can contaminate the soil if not tested for toxic elements before sale. ▪ Emissions of Particulate matter when moving/handling the waste ▪ Odour problems
Landfill	▪ Quantities of existing and future waste ▪ Waste characterization ▪ Waste segregation	▪ Land area requirement ▪ Significant transportation costs to the landfill site ▪ Utilization of methane	▪ The gas produced can be utilized for power generation or as domestic fuel for direct thermal applications ▪ Reduced GHG emissions	▪ Greatly polluted surface runoff during rainfall ▪ Soil and ground water aquifers may get

Technology	Influencing Parameters	Limitations	Benefits	Environmental Concerns
	▪ Waste collection and transportation ▪ Site selection/location ▪ Leachate estimates ▪ Potential for methane gas ▪ Lining for Landfill ▪ Quantity of new waste in case of existing landfills	may not be feasible for remote sites; ▪ Cost of pre-treatment to upgrade the gas may be high; ▪ Lack of financial resources with municipal corporations/urban local Bodies. ▪ Lack of conducive policy guidelines from State Govts. in respect of allotment of land, supply of garbage and power purchase / evacuation facilities, etc.		contaminated by polluted leachate in the absence of proper leachate collection and treatment system ▪ Spontaneous ignition due to possible methane concentrations ▪ In case of inefficient gas recovery process yielding from total amount of gas actually generated, green house gases may escape to the atmosphere
Aerobic Bioreactor Landfill	▪ Quantities of existing and future waste ▪ Waste characterization ▪ Waste segregation ▪ Waste collection and transportation ▪ Site selection/location ▪ Leachate generation rate to maintain moisture content ▪ Potential for methane gas ▪ Lining for Landfill ▪ Equipment efficiency ▪ Operational issues	▪ Risk of fire and explosive gas mixtures through addition of air to landfill ▪ Additional cost will be incurred supplying power required to add air to the landfill over that required for the anaerobic bioreactor. ▪ Although methane emission may decrease, but other hazardous and noxious chemicals e.g. nitrous oxide may be emitted	▪ More rapid waste and leachate stabilization than anaerobic bioreactor ▪ Landfill airspace savings (increased rate of landfill settlement) ▪ Reduction of methane, a GHG generation by 50-90% ▪ Capability of reducing leachate volumes by up to 100% due to evaporation ▪ Potential for landfill mining and sustainability ▪ Degradation of some recalcitrant chemicals and ammonia	▪

Technology	Influencing Parameters	Limitations	Benefits	Environmental Concerns
Anaerobic Bioreactor Landfill	▪	▪ Increased cost of basic piping, pumps and electricity for leachate recirculation ▪ The generation of methane, a green house gas is increased significantly increased and can lead to more environmental problems if not properly handled. ▪ Sealed system can result in plastic surface liners ballooning and tearing ▪ Rapid surface settlement can result in ponding ▪ Short circuiting occurs during leachate recirculation, preventing achievement of field capacity for much of the landfill ▪ Continuous pumping of leachate at two to three times the generation rate is necessary to avoid head on the liner build up ▪ A more permeable intermediate cover may be more efficient in rapidly reaching field capacity than leachate recirculation	▪ leachate storage within the waste mass, ▪ landfill airspace savings (increased rate of landfill settlement), ▪ more rapid waste stabilization than conventional landfills, ▪ increased methane generation rates (200-250% increase typical) and thus suitable for waste to energy programs, ▪ potential for limited landfill mining, and ▪ lower postclosure costs. ▪ Greenhouse Gas Abatement ▪ Environmental Protection ▪ Leachate Strength Reduction ▪ Rapid Settlement ▪ Reduced Postclosure Maintenance costs and Lowe Risks	▪

Technology	Influencing Parameters	Limitations	Benefits	Environmental Concerns
		▪ Low permeability intermediate cover and heterogeneity of the waste leads to side seeps ▪ Accelerated gas production may lead to odors if not accommodated by aggressive LFG collection ▪ Leachate infiltration and collection piping are vulnerable to irregular settling and clogging ▪ Waste is less permeable than anticipated ▪ Increased condensate production led to short circuiting of moisture into landfill gas collection pipes ▪ Storage must be provided to manage leachate during wet weather periods ▪ Conversely, leachate may not be sufficient in volume to completely wet waste, particularly for aerobic bioreactors ▪ Increased internal pore pressure due to high		

Technology	Influencing Parameters	Limitations	Benefits	Environmental Concerns
		moisture content may lead to reduced factor of safety against slope stability and must be considered during the design process ▪ Channeling leads to immediate leachate production, however long term recirculation increases uniform wetting and declining leachate generation as the waste moisture content approaches field capacity		
Biomethanation / Anaerobic Digestion	▪ Moisture Content ▪ Organic/Volatile matter ▪ C/N ratio ▪ Segregation of Organic waste ▪ Quantity of organic matter ▪ Market demand	▪ Higher capital costs ▪ Not suitable for wastes containing less biodegradable matter ▪ Non-availability of segregated waste in the municipality ▪ Lack of financial resources with ULB's and municipal corporations ▪ Requires waste segregation for improving digestion efficiency	▪ Completes natural cycle of carbon ▪ Recovery of energy & production of fully stabilized organic manure ▪ Control / Reduction of Greenhouse Gas emissions like Methane ▪ Complete destruction of Pathogens through anaerobic digestion - No transmission of disease through vectors ▪ Only pre-processing rejects - No post-processing rejects ▪ Reduced burden on Landfills ▪ Conversion efficiency: 60 to 70 % ▪ Clean combustion, compact burning, high thermal efficiency and good degree of control ▪ Environment friendly because of firewood	▪ Gas handling ▪ Fire & safety measures ▪ Proper operation of drying beds ▪ Leachate collection & treatment from sludge drying beds

Technology	Influencing Parameters	Limitations	Benefits	Environmental Concerns
			savings and reduction in CO_2 emissions ▪ Can be done on a small scale ▪ Generation of gaseous fuel ▪ Free from odor, fly menace, visible pollution ▪ Production of biogas and high grade soil conditioner ▪ Very low power requirement unlike aerobic composting, where sieving and turning of waste pile for supply of oxygen is necessary ▪ Modular construction of plant and closed treatment needs less land area	
Pelletization / Refuse Derived Fuel	▪ Segregation of Organics from MSW ▪ Quantity of organic matter ▪ Moisture content ▪ Market demand ▪ Location of the facility	▪ Competitive with large mass burn plants ▪ Requires secure markets for fuel ▪ Processing involves high electrical power consumption and maintenance ▪ Space requirement for fuel production ▪ Can cause damage to boilers and pipe work than other fuels	▪ RDF can be processed to half the calorific value of coal ▪ Lower level of heavy metals in RDF ▪ RDF can be co-fired with other fuels in a variety of industrial boilers ▪ Process is self-sustaining with value addition ▪ Resource recovery for economic gain ▪ Low risk technology ▪ Low cost option for MSW treatment and processing.	▪ Air pollution from emission of smaller quantities of organics, particulates, and metals ▪ Water pollution from leachate
Incineration	▪ Calorific value ▪ Moisture content ▪ Organic/volatile matter Fixed carbon ▪ Total Inerts	▪ Excessive moisture and inert content in waste affects net energy recovery; ▪ Auxiliary fuel support may be necessary to	▪ Achieves maximum volume reduction ▪ Incineration is a standard hygienic operation compared to open burning ▪ Heat generated can be utilized for production of steam / hot water / electricity – revenue generation	▪ Emissions - particulates, SOx and NOx emissions, chlorinated compounds, ranging from HCl to organo-compounds such as dioxins, and heavy

Technology	Influencing Parameters	Limitations	Benefits	Environmental Concerns
		sustain combustion; ▪ High capital and O&M costs. ▪ Most wastes which can safely be burned (*i.e.* vegetation, cardboard, paper) may be more useful if recovered for mulching and soil improvement. ▪ Residual ash and metal waste require disposal. ▪ Overall efficiency is low for small power stations ▪ Indian MSW has low calorific value; hence supplementary fuel is required for combustion and hence high fuel costs	▪ Less land is required and minimal burden on landfills ▪ Most suitable for high calorific value waste, etc. ▪ Relatively noiseless and odorless ▪ Thermal energy recovery for direct heating or power generation ▪ Can be located within city limits, reducing cost of waste transportation	metals ▪ Toxic metals may concentrate in ash; ▪ Fumes from low temperature incineration of mixed municipal refuse. These fumes will contain a number of toxic compounds, e.g. from burning of chlorinated plastics, solvents etc. These could be a hazard to people living and working in close proximity and are generally undesirable in the environment. Care and strict management of the waste to be burned in order to minimize contamination with undesirable waste types will be required.
Pyrolysis	▪ Calorific Value ▪ Moisture Content ▪ Fixed Carbon ▪ Total Inerts ▪ Organic/Volatile matter ▪ Segregation of Organic waste ▪ Quantity of organic matter ▪ Market demand	▪ Requires extensive pre-treatment to be able to handle MSW ▪ Higher Capital Costs and more expensive O&M ▪ Requires extensive pretreatment to handle MSW ▪ High viscosity of pyrolysis oil may be problematic for its	▪ Efficient electricity generation through combustion of gas through engines ▪ Potential to recycle a large proportion of residues depending on the process ▪ Smaller units more acceptable and part of an integrated system ▪ Capable of being integrated with other processes such as the output from MBT / Refuse Derived Fuel (RDF) production ▪ Reductions in metal volatization and	▪ Air Emissions include acid gases, dioxins and furans, nitrogen oxides, sulphur dioxide, particulates, cadmium, mercury, lead and hydrogen sulphide; ▪ Some of the residues may be hazardous in nature

Technology	Influencing Parameters	Limitations	Benefits	Environmental Concerns
		transportation and burning ▪ Net energy recovery may suffer in case of wastes with excessive moisture	particulates compared with MSE combustion technologies ▪ Apart from generating power from the waste, the slurry produced from biomethanation technology acts as a good fertilizer ▪ The quantity of waste gets reduced by nearly 60 to 90 % depending upon the waste composition. ▪ The quantity of residues is low, typically 3 % of the processed MSW. The bottom ashes are inert material which could be used as paving material. ▪ The energy can be utilized as power, heat, or combined heat and power, or as process steam. ▪ This process is cleaner than Incineration ▪ Compared to incineration, control of atmospheric pollution can be dealt with in a superior way, in techno-economic sense	
Gasification	▪ Calorific Value ▪ Organic/Volatile matter ▪ Segregation of Organic waste ▪ Quantity of organic matter ▪ Market demand ▪ Moisture Content ▪ Fixed Carbon ▪ Total Inerts	▪ Economic performance - Costlier ▪ Requires very rapid heat transfer	▪ Converts larger fraction of organics into a fuel gas ▪ Clean way to handle fuel feedstocks that have many impurities	▪ Air emissions

Table 3-7: Inputs and Outputs of Various MSW Technologies

Technology	Description	Inputs	Outputs
Composting	Composting is an organic method of producing compost manure by decomposition and stabilization of organic matter. ▪ Vermi composting ▪ Windrow composting ▪ Aerobic composting	▪ Segregated organic matter (enriched organic wastes, green waste and putrescible wastes)	▪ Compost material - sent to Market ▪ Wastewater to sewer
Landfill	Landfill is a carefully engineered depression in the ground (or built on top of the ground) into which wastes are dumped to avoid pollution to the surrounding environment. Types of landfill are: ▪ Sanitary landfill with gas recovery, leachate collection system and storm water management system ▪ Secured landfill without gas recovery ▪ Bioreactor Landfill	▪ Unsegregated / Mixed waste (in case of existing waste dumps) ▪ Rehabilitation and redesigning of existing dumptsites to mitigate existing and future impacts and to receive future waste. ▪ Segregated waste (in case of new waste) - inerts	▪ Leachate collection and treatment ▪ Landfill gas collection
Biomethanation /Anaerobic Digestion	Biomethanation is the process of conversion of organic matter in the waste (liquid or solid) to biomethane (sometimes referred to as biogas) and manure by microbial action in the absence of air, known as "anaerobic digestion."	▪ Organic material, manure (wood, agricultural waste, animal manure, etc)	▪ Biogas or Producer gas (CO, Hydrogen, Nitrogen, Methane and carbon-dioxide gases from biological processes) – can be used as dual-fuel in diesel engines, only fuel in spark engines, in gas turbines, cooking/heating appliances
Pelletization / Refuse Derived Fuel	Pelletization initially involves segregation of waste into high and low calorific value materials and then shredded and compacted into pellets with the required bulk density and later can be dried to get the appropriate heat value.	▪ Organic matter ▪ Segregation of organic waste in case of mixed (existing waste) waste	▪ Fuel Pellets
Incineration	Incineration is a process of controlled combustion for burning of wastes and residue containing combustible material.	▪ Organic/Volatile matter	▪ Ash ▪ Wastewater ▪ Flue gases
Pyrolysis	Pyrolysis is a thermal process where organic materials in the waste are broken down under pressure and at temperatures greater than 496°C in the absence of oxygen to become gas comprising of smaller molecules (Syngas)	▪ Carbon rich organic matter (sludge, plastics, wood, tyres, agricultural wastes, paper)	▪ Residue / solid slag may be recycled or disposed to landfill Gases to be combusted to get electricity

Technology	Description	Inputs	Outputs
	▪ Plasma pyrolysis		
Gasification	Gasification is the partial combustion of organic matter in the presence of restricted quantity of oxygen or air at high temperatures ▪ Plasma Arc Gasification	▪ Output from pyrolysis may be fed into gasification process	▪ Produces gas which can be combusted to generate electricity, ▪ Carbon char and ash – recycled or sent to disposal if no markets are available

3.4 Major Concerns and Exposure Pathways

3.4.1 Major concerns

Major concerns associated with waste management are

- Leachate generation
- Breeding of domestic flies and their maggots
- Methane (CH_4) and carbon-dioxide (CO_2) gas emissions
- Vegetation damage
- Community health effects
- Fire hazards in waste dump

3.4.1.1 Leachate

Leachate and runoff from waste storage and processing areas may contain organic material, phenols, nitrates, phosphorous, dissolved metals and other contaminants. Therefore, leachate if not collected and treated can contaminate soil, ground and surface water because of the following reasons:

- impact on underground soil
- ground water pollution through leachate migration from unlined landfill
- presence of heavy metals in leachate
- presence of toxic substances in ground water
- effect of leachate in underground water of the surrounding area, water becomes un-potable
- harmful substances in near field ground water
- ammonia and nitrogen fluxation

Measures should be taken to prevent, minimize and control leachate generation. After selecting any of the waste disposal alternatives, leachate is given prior importance and leachate collection & treatment system should be designed to reduce the pollution to ground & surface water bodies. Groundwater and leachate monitoring should be carried out on a regular basis at defined locations within the waste disposal area. These monitoring measures may include:

- Measuring quality and quantity of leachate generated

- Examining groundwater monitoring wells located upgrade and downgrade ground water flow for its chemical constituents

3.4.1.2 Breeding of flies, insets and rodents

Birds are attracted to landfill sites in large numbers, particularly where sites receive appreciable amounts of food wastes. Usually only large birds such as eagles, gulls, *etc*., are regarded as a nuisance. Bird control techniques should be carefully planned taking into account the species likely to be affected. Measures which can be used to mitigate bird nuisance include the employment of good landfill practice, working in small active areas and progressive prompt covering of waste, together with the use of bird scaring techniques. Measures involving explosions or distress calls have inherent adverse environmental impacts in terms of noise. These birds also create problems to aircraft travel.

3.4.1.3 Methane and carbon-dioxide gas emissions

MSW contains significant portions of organic materials that produce a variety of gaseous products when dumped, compacted, and covered in landfills. Anaerobic bacteria thrive in the oxygen-free environment, resulting in the decomposition of the organic materials and the production of primarily carbon dioxide and methane. Methane is likely to release out of the landfill. Landfill gas facilities capture the methane (the principal component of natural gas) and combust it for energy. Source separation and recycling drastically reduces the generation of these gases.

Carbon dioxide and methane are the two major GHGs causing global warming. Carbon dioxide and methane together are 81% of GHGs. Methane is 21 times more potent than CO_2 and therefore reduction of both gases is required.

General options with landfill gas:

- Flaring – loss of usable energy
- Boiler – produce heat
- Internal combustion engine – generates motive power
- Gas turbines – makes electricity
- Fuel cell – makes electricity
- Convert methane to methyl alcohol
- Clean it up enough to pipe it to other industries or into natural gas lines

3.4.1.4 Vegetation damage

There will be stress on vegetation due to release of landfill gas in the surrounding areaand from potential contaminated (from solid waste) surface water.

3.4.1.5 Community health impacts

Community health impacts may include emissions from solid wastes and construction site issues. Some of the impacts are listed below.

- Occupational and health hazards amongst MSW workers
- Potential to create health hazards through disposal facilities
- Impact on human health because of biogas, leachate, contaminated runoff or hazardous waste decomposition product
- Impact of odor and mosquito on human health through uncontrolled dumping
- Pollution of underground water and neighboring well water
- Acute and genetic toxicity of landfill leachate
- Impact on biological entities such as animals, birds and pathogens
- Health impacts due to burning of solid waste which may result in breathing problems, burning of eyes, *etc*
- Uncollected garbage and litter spread beyond the waste management facility

3.4.1.6 Fire hazards in waste dump

Biodegradable wastes can be combustible and aerobic degradation can produce sufficient heat to cause spontaneous combustion in certain circumstances. Waste in some instances can contain ashes and other ignitable materials that burst into flame under wind conditions or when in contact with flammables. In landfills methane is generated by anaerobic digestion and can potentially ignite when encountered with ignition sources. Methane in landfill gas can get trapped in underground cavities, and even move along geologic discontinuities, to pose a risk of explosion.

3.4.2 Exposure pathways

Exposure pathway is the path due to which exposure of the receptor takes place. Emissions from the solid waste (gaseous, solid as well as liquid effluents) can cause damage to human health, aquatic and terrestrial ecology as well as material due to various exposure routes (pathways). For example adverse effects of solid waste open dump on human health can derive from the direct impact of noxious gases on the organism and/or their indirect impact via the food chain and changes in the environment. Especially in connection with high levels of fine particulates, noxious gases like methane, carbon dioxide, SO_2 and NOx can lead to respiratory diseases. The duration of exposure is decisive. Injurious heavy metals (e.g., lead, mercury and cadmium) can enter the food chain and, hence, the human organism by way of drinking water and vegetable and animal products. Climatic changes such as warming and can occur due to greenhouse effect of methane, CO_2 and other trace gases, resulting in long-term detrimental effects on human health.

3.5 Financial Aspects of Solid Waste Management

Almost every municipality in India is under financial pressure. The majority does not have adequate accounting and budgeting system and does not operate on a financial planning basis. This makes the process of understanding costs, commitments and revenues difficult for management. Therefore to address this situation a proper financial planning should be framed which addresses all the investment costs and revenues of the system. Very few, if not no, municipalities maintain proper financial cost accounting systems for different elements of solid waste management. For assessing economic

sustainability of the MSW management systems, the municipalities have to develop simple but effective financial management systems.

3.5.1 Investments or operating costs

3.5.1.1 Waste collection

As per "Overview and Challenges of Improving the Management of Solid Waste in India" the collection costs of wastes range from Rs. 300 to 400 per tonne.

3.5.1.2 Waste transportation

As per "Overview and Challenges of Improving the Management of Solid Waste in India" the transportation costs of wastes range from Rs. 300 to 400 per ton and may vary from place to place depending on the following factors.

- Total quantity generated per day
- Frequency of waste collection
- Quantity to be transported/day
- Shift operations
- Quantity per shift
- Distance to be covered per trip
- No. of trips vehicle can make (distance, loading/unloading system)
- Average weight carried by vehicle
- Number and type of vehicles

3.5.1.3 Disposal facilities

As per "Overview and Challenges of Improving the Management of Solid Waste in India" the treatment and disposal costs of wastes on an average (excluding land) range from Rs. 400 to 600 per ton. However, for planning purposes municipalities should investigate options for both self owned and operated systems and contracted systems noting the high uncertainties at present on realistic contract charges.

3.5.1.4 Operation and maintenance in MSW management

The municipalities will undergo annual expenditure on various activities such as handling waste, supervision, primary collection, transportation, sweeping, processing and disposal. Based on the type of disposal option the cost for maintenance of those facilities would vary.

3.5.1.5 Monitoring the activities in MSW management

Based on the type of disposal option the monitoring costs for those facilities would vary.

3.5.1.6 Training the Personnel

There shall be knowledge and skill development programmes to the key personnel in MSW Management to improve their performance and competence. The training programmes shall be organized by the training unit of the municipality. The expenses on these training programmes will be borne by either the municipality or the private company which is hired by the municipality/local bodies.

3.5.1.7 Awareness programmes in the community

The main objective of these programmes is to create awareness among people in the community to give a value to MSW and have sustainable management of solid waste.

3.5.1.8 Organizational expenditure

One time establishment costs/recurring costs

3.5.2 Revenue generation

3.5.2.1 User charges

The value that people place on MSW management is the amount that they are prepared to pay. The charges that a user may afford to pay may range between Rs. 30 to 50 per month in case of households and can be directly collected from them based on the income level groups or generation of wastes which ever is feasible option. The charges can be quite high (> 600) for hotels when compared to residential houses.

3.5.2.2 Sale of recyclables

The basic recyclable wastes are glass, plastic, metals, synthetic rubber, leather, rags, *etc.* These recyclables can be typically removed at the point of collection or at the disposal facility which reduces the total volumes and provides income to the groups involved but also reduces the nominal value of the overall waste.

3.5.2.3 Sale of compost

In India MSW has high organic content and composting would be one of the most popular option where some of the private companies would be interested in taking waste from municipalities and turn into compost on a commercial basis.

MSW composting facilities must be designed for flexibility. Changes in the regulatory environment, in market specifications, and in the waste stream itself are likely to be significant in future. With any new technology, "state of the art" is likely to have ephemeral meaning for MSW composting facilities. This is particularly true with the physical processing steps, where changes in the amount and type of waste collected and the product quality required are likely to significantly impact optimal facility design. An MSW composting facility must be able to adapt if it is to play a long term role in responsible waste management. In order to market the compost produced from MSW the following should be considered.

- There must be a value addition of compost before marketing to make it a profitable proposition.
- The composter should be provided with back ended transport subsidy to transport compost in bulk within 50 km radius of compost plant for direct selling to farmers.
- Massive awareness generation campaign on utility of compost to the fertilizers.
- Examining the compost for toxic substances and its effect on soil and water quality before its sale.
- Identifying the potential users to determine the type of compost that should be produced.

3.5.2.4 Waste to energy

There are small waste to energy plants in India which work on commercial basis but practically rely on Government subsidy both in capital and operational particularly in the form of preferential power tariff imposed up on already financially weak power systems.

3.5.2.5 Carbon finance

Carbon finance through CDM (Clean Development Mechanism) of Kyoto protocol offers significant opportunities in India for an array of GHG (Green House Gas) emission reduction projects. MoEF, GoI has formulated the interim sustainable development criteria (social, economic, environmental and technological well being), which need to be met for CDM projects to gain approval in India. India already has environmental regulations requiring investment projects to carry out EIAs in place. CDM projects would need to abide by such national legislation and carry out the necessary EIAs.

Control of green house gases is a good practice for number of reasons including safety, energy production, reducing green house gas effects. Methane is a powerful green house gas that has financial incentives for its control in the context of climate change. There are certain groups which gives only initial capital subsidy and other only payments for reduction of carbon emissions during the operations.

The principle would be either capturing and destroying the methane or changing the systems to prevent its generation and claiming for emission reductions. These emission reductions once verified can be sold for cash on an increasingly open carbon market.

In theory the CDM works like this: an investor from an industrialized country, can invest in, or provide finance for, a project in a developing country that reduces greenhouse gas emissions so that they are lower than they would have been without the extra investment – *i.e.* compared to what would have happened without the CDM under a business as usual outcome. The investor then gets credits – carbon credits – for the reductions and can use those credits to meet their Kyoto target. The envisaged project has to fulfill certain eligibility criteria in order to be accepted as a CDM measure according to the Kyoto Protocol.

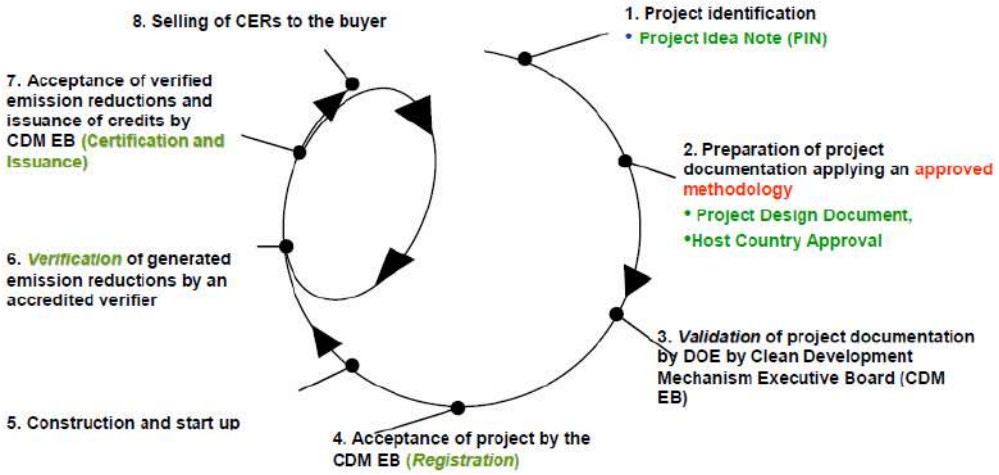

Figure 3-8: CDM Project cycle

The purpose of the CDM is to benefit both the investor and host countries by contributing to sustainable development in the host developing countries and by allowing investor countries to meet their GHG reduction targets at the lowest possible cost by taking advantage of the lower marginal cost of reducing GHG emissions in developing countries. It is the sole prerogative of the host country to confirm whether the project contributes to its sustainable development.

Incase of MSW management following are the key areas for availing carbon finance:

- Conversion of carbonaceous matter into CO_2 instead of methane by aerobic treatment methods.
- Methane collected in the anaerobic treatment processes could be used for beneficial applications and gets finally converted in to CO_2 upon burning/flaring.
- Carbonaceous matter having calorific value can be availed as energy by thermal oxidation. This process also converts carbon into CO_2

For specific details on CDM benefits from MSW management, UNFCC website may be referred. Table 3-8 shows indicative estimates of comparative and potential CF revenues for various MSW treatment technologies.

Table 3-8: Indicative Carbon Revenues Potential using Various MSWM Technologies

MSW Treatment and Disposal Options	CO_2 Emissions (t CO_2 E/t MSW)	Potential Emission Reductions (t CO_2 E/t MSW)	Carbon Finance for Treatment of MSW Rs/t MSW
Assuming landfill without LFG recovery as baseline	-	-	-
Landfill with LFG recovery and flare	0.20 – 0.25	0.95 – 1.20	175 – 200
Landfill with LFG and energy	0.21 (may be less if energy component is	More than 0.95	More than 175 Rs/ton

MSW Treatment and Disposal Options	CO_2 Emissions (t CO_2 E/t MSW)	Potential Emission Reductions (t CO_2 E/t MSW)	Carbon Finance for Treatment of MSW Rs/t MSW
generation	considered)		
Composting	0 (may be less if replacement of chemical fertilizer is considered)	More than 1.16	More than 200 Rs/ton
Bio-methanation	0 (may be less if energy and fertilizer components are considered)	More than 1.16	More than 225 Rs/ton

Source: Carbon finance business estimates

3.5.2.6 Royalty on waste

The private companies may take the responsibility of collecting the waste from certain parts of the municipality and generate revenues from the waste and shall pay the fee to the municipality for the same.

According to the report on "Overview and Challenges: Improving Management of Solid Waste in India, Environment and Social Development Unit, South Asia Region, World Bank, May 2006" pilot Action Plans were developed for three cities each in Karnataka and Andhra Pradesh covering a range of size and circumstances. Some of the key parameters from these Action Plans such as the cost per ton of MSW collected and the ratio of workers to waste are summarized in the following Table 3-17. The data is presented as ranges without identifying the uncertainties in some of the numbers.

Table 3-9: Summary of Key Parameters from Action Plans

Parameters for Benchmarking	Large Cities (Above 1.5 million)	Mid size Towns (between 0.5-1.5 million)	Small Towns (less than 0.5 million)	Typical Range for Hilly Towns
MSW management expenditure in Rs per capita per annum	165-175	150-180	120-150	350-400 *
MSW Management expenditure as % of total municipal revenue expenditure	15-25	15-25	20-40	25-45
MSW management cost per ton (Rs)	900-1200	800-1200	800-1600 **	2500-3000 #
Relative costs per ton by size/population (taking mid-size town as 1.00)	0.22-0.27	1.00-1.11	2.78-5.00	4.44-7.78 ##
Salaries as % of overall MSW management costs	45-55	60-70	65-75	80-90
Ratio of worker per ton of waste managed	3.5-4.5	2.5-6.0	2.5-5.0	8.0-16.0
Cost of primary collection as % of total MSW management expenditure	25-30	40-70	30-40	20-40
Cost of Transportation as % of total MSW management	20-25	10-20	10-15	15-25

Parameters for Benchmarking	Large Cities (Above 1.5 million)	Mid size Towns (between 0.5-1.5 million)	Small Towns (less than 0.5 million)	Typical Range for Hilly Towns
expenditure				
Cost of MSW management contract as % of total MSW management expenditure	35-40	25-30	5-10	<5

Notes:

** For hilly towns the municipal expenditure is generally high due to specific revenue importance such as tourism and seasonal variation in population, etc.*

*** Higher percentage of MSW management expenditure is observed in smaller cities where sub contracting of MSW management services as well as level of services is generally lower.*

 # Higher costs in hilly towns are attributed to difficult terrain and extreme climatic conditions.

MSW management costs in hilly town varies significantly depending on geography and tourist importance

Source: Overview and Challenges: Improving Management of Solid Waste in India, Environment and Social Development Unit, South Asia Region, World Bank, May 2006.

3.6 Summary of Applicable National Regulations

3.6.1 General description of major statutes

A compilation of legal instruments which are applicable to CMSWM facilities is annexed as **Annexure IV**.

3.6.2 General standards for discharge of environmental pollutants

General standards for discharge of environmental pollutants as per CPCB are given in **Annexure V**.

3.6.3 Requirements for common MSW management facilities

In order to regulate the waste from different sources of waste generation in the municipality, CPCB has notified Municipal Solid Waste (Management & Handling) Rules, 2000 which are applicable to every municipal authority responsible for collection, segregation, storage, transportation, processing and disposal of municipal solid. Corresponding schedules in the rules are annexed as **Annexure III**.

The Rule contains four Schedules:

- Schedule-I: Implementation Schedule
- Schedule-II: Specifications relating to collection, segregation, storage, transportation, processing and disposal of MSW.
- Schedule-III: Specifications for landfilling indicating; site selection, facilities at the site, specifications for landfilling, Pollution prevention, water quality monitoring,

ambient air quality monitoring, Plantation at landfill site, closure of landfill site and post care.

- Schedule-IV: Waste processing options including; standards for composting, treated leachates and incinerations.

3.6.4 FCO Standards for compost quality

To ensure adequate availability of right quality of fertilizers at right time and at right price to farmers, the fertilizer was declared as an Essential Commodity and Fertilizer Control Order (FCO) was promulgated under Section 3 of Essential Commodities Act, 1955 to regulate, trade, price, quality and distribution of fertilizers in the country.

For the first time on the consistent demand of State Governments, the bio-fertilizers and organic manures have been brought under the regulatory mechanism. In the Schedule III & IV of FCO, 1985, the specification of important bio-fertilizers (namely; Phosphate Solublizing Bacteria (PSB), Azotobactor, Azospirrillium, Rhizobium) have been included. Fertilizer Control (Amendment) Order, 2006 was notified, in which organic manure (namely Vermi Compost, City Compost & Press mud) has been notified besides their tolerance limit, method of sampling and analysis. However, this particular amendment is yet to be made applicable. FCO standards for compost quality are given in **Annexure VI**.

4. OPERATIONAL ASPECTS OF EIA

Prior environmental clearance process has been revised in the Notification issued on 14th September, 2006, into following four major stages *i.e.*, screening, scoping, public consultation and appraisal. Each stage has certain procedures to be followed. This section deals with all the procedural and technical guidance, for conducting objective-oriented EIA studies, their review and decision-making. Besides, the Notification also classifies projects into Category A, which requires prior environmental clearance from MoEF and Category B from SEIAA/UTEIAA.

Consistency with other requirements

- Clearance from other regulatory bodies is not a pre-requisite for obtaining the prior environmental clearance and all such clearances will be treated as parallel statutory requirements.
- Consent for Establishment (CFE) and Prior Environmental Clearance are two different legal requirements; a project proponent is required should acquire. Therefore, these two activities can be initiated and proceeded with simultaneously.
- If a project falls within purview of CRZ and EIA Notifications, then the project proponent is required to take separate clearances from the concerned Authorities.
- Rehabilitation and Resettlement (R&R) issues need not be dealt under the EIA Notification as other statutory bodies deal with these issues. However, socio-economic studies may be considered while taking environmental decisions.

4.1 Coverage of Common MSW Management Facility under the Purview of Notification

All the new CMSWMF projects including expansion and modernization require prior environmental clearance. Based on pollution potential, all these projects are classified into Category B.

Besides there is general condition, when it applies, a Category B project will be treated as Category A project. These conditions are discussed in subsequent sections.

The sequence of steps in the process of prior environmental clearance for Category A projects and the Category B projects are shown in Figure 4.1 and Figure 4.2 respectively. The time lines indicated against each stage are the maximum permissible time lines set in the Notification for said task. In case the said task is not cleared/objected by the concerned Authority, within the specified time, said task is deemed to be cleared, in accordance tot eh proposal submitted by the proponent. Each stage in the process of prior environmental clearance for the CMSWMF projects is discussed in subsequent sections.

In case of Expansion or Modernization of the developmental Activity:

- Any developmental activity, which has an issued EIA clearance (existing facility), when undergoes expansion or modernization (change in process or technology) with increase in handling capacity is required to submit new application for EIA clearance.

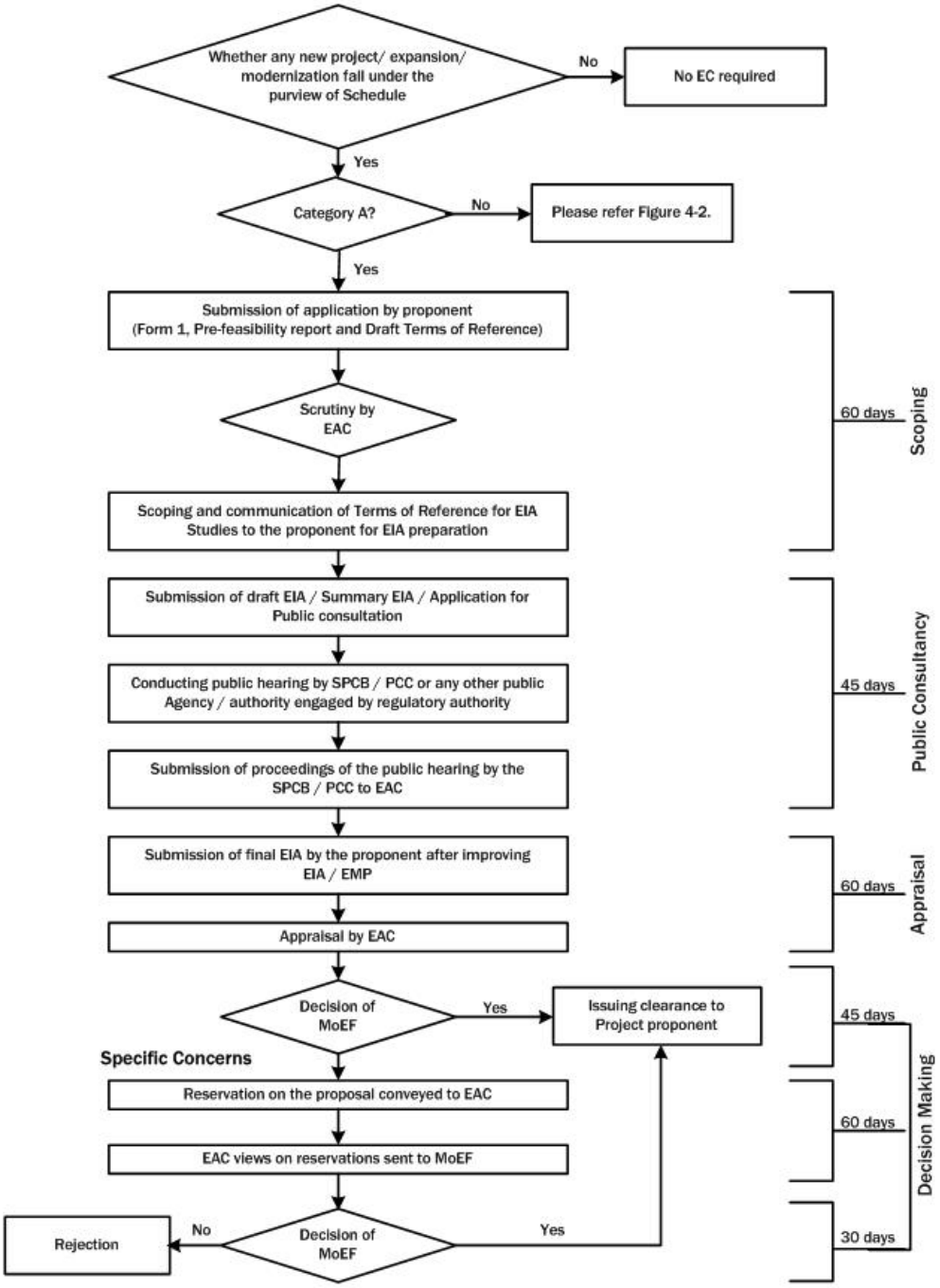

Figure 4-1: Prior Environmental Clearance Process for Activities Falling Under Category A

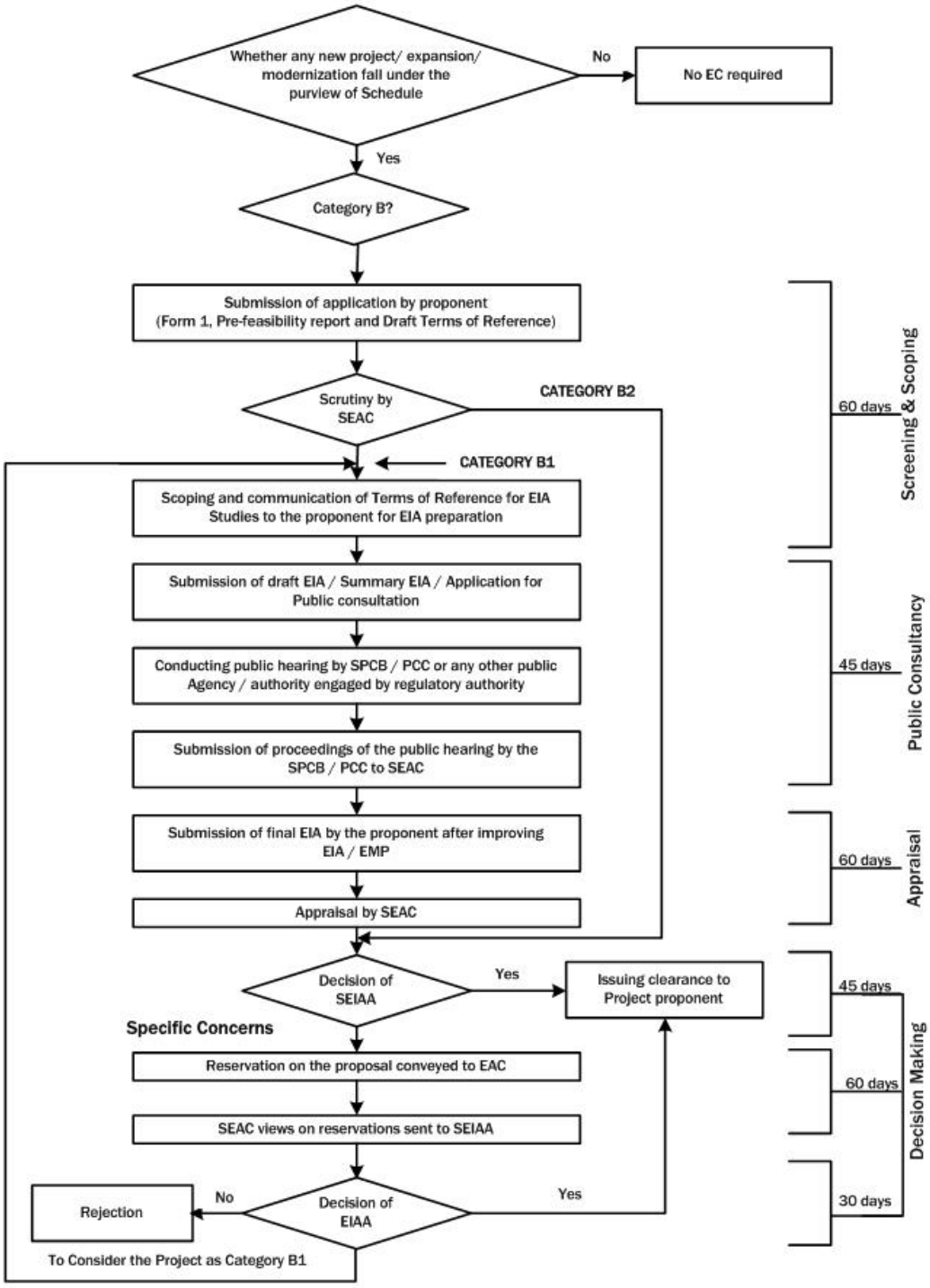

Figure 4-2: Prior Environmental Clearance Process for Activities Falling Under Category B

4.2 Screening

Screening of the project shall be performed at the initial stage of the project development so that proponents are aware of their obligations before deciding on the budget, project design and execution plan.

This stage is applicable only for Category 'B' developmental activity *i.e.* if general conditions are applicable for a Category B project, then it will be treated as Category A project. Besides, screening also refers to the classification of Category B projects into either Category B1 or Category B2. Category B1 projects require to follow all the stages, that are applicable for a Category A project, but are processed at the SEIAA/UTEIAA. Category B2 projects on the other hand, do not require either EIA or public consultation.

As per the Notification, classification of the Category B projects falls under the purview of the SEAC. This manual provides certain guidelines to the stakeholders for classification of Category B1 and Category B2.

4.2.1 Applicable conditions for Category B projects

General condition

- Any CMSWMF project (usually falling under Category B) will be treated as Category A, if located in whole or in part within 10 km from the boundary of:
  - Protected areas notified under the Wildlife (Protection) Act, 1972,
  - Critically polluted areas as notified by the CPCB from time to time
  - Eco-sensitive areas as notified under section 3 of the E(P) Act, 1986, such as Mahabaleshwar Panchgani, Matheran, Panchmarhi, Dahanu, Doon valley and
  - Inter-State boundaries and international boundaries - provided the requirement regarding distance of 10 km of the inter-state boundaries can be reduced or completely done away with by an agreement between the respective States/UTs sharing the common boundary in case the activity does not fall within 10 km of the areas mentioned above.
- If any of the conditions listed in above general condition applies, then a Category B project will be treated as Category A
- The SEIAA shall base its decision on the recommendations of a State/UT level EAC for the purpose of prior environmental clearance.
- In absence of a duly constituted SEIAA or SEAC, a Category B project shall be appraised at Central level *i.e.* at the MoEF
- The EAC at the State/UT level shall screen the projects or activities in Category B. SEAC shall meet at least once every month

4.2.2 Criteria for classification of Category B1 and B2 projects

The classification of Category B projects or activities into B1 or B2 (except the project or activities listed in item 8(b) in the schedule to the EIA Notification, 2006) will be determined based on whether or not the project or activity requires further environmental studies for preparation of an EIA for its appraisal prior to the grant of prior environmental clearance. The necessity of which will be decided, depending upon the nature and location specificity of the project, by SEAC after scrutiny of the applications seeking prior environmental clearance for Category B projects or activities.

The projects requiring an EIA report shall be included in Category B1 and remaining projects will fall under Category B2 and will not require an EIA report and public consultation.

Situation under which projects can be considered as B2:

- All MSW projects to be considered under B1 Category except projects dealing with the capping of existing dump sites (including capturing of landfill gases for power generation)

4.2.3 Application for prior environmental clearance

- The project proponent, after identifying the site and carrying out a pre-feasibility study, is required to apply for the prior environmental clearance using Form 1 given in **Annexure VII**. The proponent has to submit the filled in Form 1 along with the pre-feasibility report and draft ToR for EIA studies to the concerned Authority *i.e*. MoEF, Government of India for Category A projects and the SEIAA in case of Category B projects. Please refer subsequent sections for the information on how to fill the Form 1, contents of pre-feasibility report and draft sector-specific ToRs.
- Prior environmental clearance is required before starting any construction work, or preparation of land is started on the identified site/project or activity by the project management, except for securing the land.
- If the application is made for a specific developmental activity, which has an inherent area development component as a part of its project proposal and the same project also attracts the construction and area development provisions under 8a and 8b of the Schedule, then the project will be seen as a developmental activity other than 8a and 8b of the Schedule.

4.2.4 Siting guidelines

These are the guidelines, stakeholders may consider while siting the developmental projects, to minimize the associated possible environmental impacts. While in some situations, adhering to these guidelines is difficult and unwarranted. Therefore these guidelines may be kept in the background, as far as possible, while taking the decisions. Setting up of such facilities in critically polluted areas identified by MoEF from time-to-time may be avoided to the maximum extent possible. Please refer **Annexure VIII** for details of critically polluted industrial areas and clusters/potential impact zone.

Siting guideline specifications for landfill as per MSW rules 2000 include the following:

- In areas falling under the jurisdiction of 'Development Authorities' it shall be the responsibility of such Development Authorities to identify the landfill sites and hand over the sites to the concerned municipal authority for development, operation and maintenance. Elsewhere, this responsibility shall lie with the concerned municipal authority.
- Selection of landfill sites shall be based on examination of environmental issues. The Department of Urban Development of the State or the Union territory shall co-ordinate with the concerned organizations for obtaining the necessary approvals and clearances.
- The landfill site shall be planned and designed with proper documentation of a phased construction plan as well as a closure plan.

- The landfill sites shall be selected to make use of nearby wastes processing facility. Otherwise, wastes processing facility shall be planned as an integral part of the landfill site.
- The existing landfill sites, which continue to be used for more than five years, shall be improved in accordance of the specifications given in this Schedule.
- Biomedical wastes shall be disposed off in accordance with the Bio-medical Wastes (Management and Handling) Rules, 1998 and hazardous wastes shall be managed in accordance with the Hazardous Wastes (Management and Handling) Rules, 1989, as amended from time to time.
- The landfill site shall be large enough to last for 20-25 years.
- The landfill site shall be away from habitation clusters, forest areas, water bodies, monuments, National Parks, Wetlands and places of important cultural, historical or religious interest.
- A buffer zone of no-development shall be maintained around landfill site and shall be incorporated in the Town Planning Department's land-use plans.
- Landfill site shall be away from airport including airbase. Necessary approval of airport or airbase authorities prior to the setting up of the landfill site shall be obtained in cases where the site is to be located within 20 km of an airport or airbase.

4.3 Scoping for EIA Studies

Scoping exercise is taken-up soon after the project contours are defined. The primary purpose of scoping is to identify the concerns and issues which may affect the project decisions. Besides, scoping defines EIA study requirements and boundaries of the EIA study.

Scoping refers to the process by which the EAC, in case of Category 'A' projects or activities, and SEAC in the case of Category 'B1' projects, including applications for expansion and/or modernization of existing projects, determine ToR for EIA studies addressing all relevant environmental concerns for the preparation of an EIA Report for a particular project.

- Project proponent shall submit the application to the concerned authority. The application (Form 1 as given in Annexure VII) shall be attached with pre-feasibility report and proposed ToR for EIA Studies. The proposed sequence to arrive at the draft ToR is discussed below:
  - Precisely, the pre-feasibility report summarizes the project details and also the likely environmental concerns based on the secondary information, which will be availed for filling the Form 1.
  - From the pre-feasibility report and the Form 1, valued environmental components (VECs) may be identified for a given project (the receiving environment/social components, which are likely to get effected due to the project operations/activities).
  - Once the project details from the pre-feasibility report & Form 1; and VECs are identified, a matrix establishing the interactions which can lead to the effects/impacts could be developed (Qualitative analysis).
  - For each identified possible effect in the matrix, significance analysis could be conducted to identify the impacts, which needs to be further studied (quantitative

analysis) in the subsequent EIA studies. All such points will become the part of the draft ToR to be proposed by the project proponent along with the application form. The draft ToR shall include applicable baseline parameters (annexure XI) and impact prediction tools (annexure XIII) proposed to be applied.

- The information to be provided in pre-feasibility report, guidelines for filling Form 1 and guidelines for developing draft ToR is summarized in the subsequent sections.
- Authority consults the respective EAC/SEAC to reply to the proponent. The EAC/SEAC concerned reviews the application form, pre-feasibility report and proposed draft ToR by the proponent and make necessary additions/deletions to make it a comprehensive ToR that suits the statutory requirements for conducting the EIA studies.

- A site visit by sub-committees of EAC/SEAC concerned will be planned, only if considered necessary by the EAC/SEAC concerned with the written approval of the chairperson of EAC/SEAC concerned. Project proponent will facilitate such site visits of the sub-committees.
- EAC/SEAC shall provide an opportunity to the project proponent for presentation and discussions on the proposed project and related issues as well as the proposed ToR for EIA studies. If the State Government desires to present its views on any specific project in the scoping stage, it can depute an officer for the same at the scoping stage to EAC, as an invitee but not as a member of EAC. However, non-appearance of the project proponent before EAC/SEAC at any stage will not be a ground for rejection of the application for the prior environmental clearance.
- In case of a new or expansion project in an identified problem area by the CPCB, then the Ministry may invite representative SEIAA to present their views, if any at the stage of scoping, to the EAC.
- The final set of ToRs for EIA Studies shall be conveyed to the proponent by the EAC/ SEAC within sixty days of the receipt of Form 1 and pre-feasibility report. If the finalized ToR for EIA studies is not conveyed to the proponent within sixty days of the receipt of Form 1, the ToR for EIA studies suggested by the proponent shall be deemed as the final and will be approved for the EIA studies.
- The final ToR for EIA Studies shall be displayed on the websites of the MoEF/SEIAA.
- Applications for prior environmental clearance may be rejected by the concerned Authority based on the recommendations by the concerned EAC or SEAC at the scoping stage itself. In case of such rejection, the decision together with reasons for the same shall be communicated to the proponent in writing within sixty days of the receipt of the application.
- The final EIA report and the other relevant documents submitted by the proponent shall be scrutinized by the concerned Authority strictly with reference to the approved ToR for EIA studies.

4.3.1 Pre-feasibility report

The pre-feasibility report should include, but not limited to highlight the proposed project information, keeping in view the environmental sensitivities of the selected site, technology options, leachate treatment, *etc*. Information required in pre-feasibility report varies from case to case even in the same sector depending upon the local environmental setting within which the facility is located/proposed. However, the information which may be furnished in the pre-feasibility report may include as under:

I. Executive summary

II. Project details: Description of the project including in particular;

- a description of the main characteristics of the waste management practices
- an estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, heat, radiation, *etc.*) resulting from the operation of the proposed project.
- a description of the physical characteristics of the whole project and the land-use requirements during the construction and operational phases

III. Selection of site based on least possible impacts

- An outline of the main alternatives studied by the developer and an indication of the main reasons for this choice, taking into account the environmental effects.

IV. Anticipated impacts based on project operations on receiving environment

- A description of the aspects of the environment likely to be significantly affected by the proposed project, including, in particular, population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape and the inter-relationship between the above factors.
- A description of the likely significant effects of the proposed project on the environment resulting from:
  - existence of the project
  - emission of pollutants, the creation of nuisances
  - project proponent's description of the forecasting methods used to assess the effects on the environment

V. Proposed broad mitigation measures which could effectively be internalized as project components to have environmental and social acceptance of the proposed site

- A description of key measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment

VI. An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the developer in compiling the required information

Details of the above listed points which may be covered in pre-feasibility report are listed in **Annexure IX**.

4.3.2 Guidance for providing information in Form 1

The information given in specifically designed pre-feasibility report for this developmental activity may also be availed for filling Form 1.

Form 1 is designed to help users identify the likely significant environmental effects of proposed projects right at the scoping stage. There are two stages for providing information under two columns:

- First - identifying the relevant project activities from the list given in Column 2 of Form 1. Start with the checklist of questions set out below and complete Column 3 by answering:
  - Yes - if the activity is likely to occur during implementation of the project;
  - No - if it is not expected to occur;
  - May be - if it is uncertain at this stage whether it will occur or not.
- Second - Each activity for which the answer in Column 3 is "Yes" the next step is to refer to the fourth column which quantifies the volume of activity which could be judged as significant impact on the local environmental characteristics, and identify the areas that could be affected by that activity during construction /operation / decommissioning of the project. Form 1 requires information within 15 km around the project, whereas actual study area for EIA will be as prescribed by respective EAC/SEAC. Project proponent will need information will be needed about the surrounding VECs in order to complete this Form 1.

4.3.3 Identification of appropriate valued environmental components

VECs are components of natural resources and human world that are considered valuable and are likely to be affected by the project activities. Value may be attributed for economic, social, environmental, aesthetic or ethical reasons. VECs represent the investigative focal point for further EIA process. The indirect and/or cumulative effects can be concerned with indirect, additive or even synergistic effects due to other projects or activities or even induced developments on the same environmental components as would be considered direct effects. But such impacts tend to involve larger scale VECs such as within entire region, river basins or watersheds; and, broad social and economic VECs such as quality of life and the provincial economy. Once VECs are identified then appropriate indicators are selected for impact assessments on the respective VECs.

4.3.4 Methods for identification of impacts

There are various factors which influence the approach adopted for the assessment of direct, indirect, cumulative impacts, *etc*. for a particular project. The method should be practical and suitable for the project given the data, time and financial resources available. However, the method adopted should be able to provide a meaningful conclusion from which it would be possible to develop, where necessary, mitigation measures and monitoring. Key points to consider when choosing the method(s) include:

- Nature of the impact(s)
- Availability and quality of data
- Availability of resources (time, finance and staff)

The method chosen should not be complex, but should aim at presenting the results in a way that can be easily understood by the developer, decision maker and the public. A comparative analysis of major impact identification methods is given in Table 4-1.

Table 4-1: Advantages and Disadvantages of Impact Identification Methods

	Description	Advantages	Disadvantages
Checklists	▪ Annotate the environmental features that need to be addressed when identifying the	▪ Simple to understand and use	▪ Do not distinguish between direct

	Description	Advantages	Disadvantages
	impacts of activities in the project	▪ Good for site selection and priority setting ▪ Simple ranking and weighting	and indirect impacts ▪ Do not link action and impact ▪ The process of incorporating values can be controversial
Matrices	▪ Identify the interaction between project activities (along one axis) and environmental characteristics (along other axis)using a grid like table ▪ Entries are made in the cells which highlights impact severity in the form of symbols or numbers or descriptive comments	▪ Link action to impact ▪ Good method for displaying EIA results	▪ Difficult to distinguish direct and indirect impacts ▪ Significant potential for double-counting of impacts
Networks	▪ Illustrate cause effect relationship of project activities and environmental characteristics ▪ Useful in identifying secondary impacts ▪ Useful for establishing impact hypothesis and other structured science based approaches to EIA	▪ Link action to impact ▪ Useful in simplified form for checking for second order impacts ▪ Handles direct and indirect impacts	▪ Can become very complex if used beyond simplified version
Overlays	▪ Map the impacts spatially and display them pictorially ▪ Useful for comparing site and planning alternatives for routing linear developments ▪ Can address cumulative effects ▪ Information incentive	▪ Easy to understand ▪ Good to display method ▪ Good siting tool	▪ Address only direct impacts ▪ Do not address impact duration or probability
GIS	▪ Maps the impacts spatially and display them pictorially ▪ Useful for comparing site and planning alternatives for routing linear developments ▪ Can address cumulative effects ▪ Information incentive	▪ Easy to understand ▪ Good to display method ▪ Good siting tool ▪ Excellent for impact identification and analysis	▪ Do not address impact duration or probability ▪ Heavy reliance on knowledge and data ▪ Often complex and expensive
Expert System	▪ Assist diagnosis, problem solving and decision making ▪ Needs inputs from user by answering systematically developed questions to identify impacts and determine their mitigability and significance ▪ Information intensive, high investment methods of analysis	▪ Excellent for impact identification and analysis ▪ Good for experimenting	▪ Heavy reliance on knowledge and data ▪ Often complex and expensive

The project team made an attempt to construct an impact matrix considering major project activities (generic operations) and stage-specific likely impacts which is given in Table 4-2.

While the impact matrix is each project-specific, Table 4-2 may facilitate the stakeholders in identifying a set of components and phase-specific project activities for determination of likely impacts.

Table 4-2: Matrix of Impacts

			PHASE I					PHASE II						PHASE III																
			Pre Construction					Construction/ Establishment						Operation and Maintenance																
			CMSWM Facility					Landfill						General operations at the disposal facilities						Landfill					Composting			RDF		Biomethanation	Incineration
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	32	33
ENVIRONMENT	COMPONENT	Project Activities / Parameter/ factor	Detailed topographic survey	Land acquisition	Site cleaning	Burning of waste s, refuse and cleared vegetation	Site preparation / change in topography	Civil works such as earth moving and building of structures including temporary structures	Heavy equipment operations	Disposal of construction waste	Generation of sewerage	Influx of construction workers	Deforestation	Transportation of waste to the facility	Movement of vehicles	Water requirement at the facility	Influx of workers	Temporary storage of waste	Separation of waste	Liners	Drainage Layers	Waste handling and landfilling	Leachate management	Landfill gas collection and management	Waste handling, mixing and processing	Leachate management	Compost storage	Drying and palletizing	Packaging and storage	Gas capturing and management	Ash management
Physical	Soil	Erosion risks			*								*																		
		Contamination / quality																		*	*	*	*		*	*	*		*		*
	Resources	Construction material-stone, aggregates						*		*		*								*	*	*	*		*	*					
		Land especially undeveloped		*	*	*	*	*					*																		

			PHASE I					PHASE II						PHASE III																
			Pre Construction					Construction/ Establishment						Operation and Maintenance																
			CMSWM Facility					Landfill						General operations at the disposal facilities						Landfill				Composting			RDF		Biomethanation	Incineration
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	32	33
		or agricultural land																													
	Water	Water quality									*					*		*		*	*	*	*		*	*					*
		Alteration of hydraulic regime						*													*										
		Alteration of surface run off and interflow					*	*		*			*																		
	Air	Air quality				*			*					*	*			*				*		*	*			*	*	*	*
		Noise and odour				*			*					*	*			*				*	*	*	*			*			
Biological	Terrestrial Flora	Terrestrial ecology/ land use			*	*	*	*										*					*								*
	Aquatic Biota	Aquatic ecology			*		*	*			*		*			*		*					*								*
	Terrestrial Fauna	Disturbance of habitats by noise or vibration				*	*		*					*	*							*			*						
		Environmental hazards												*	*	*		*				*	*	*	*	*		*	*	*	*

			PHASE I					PHASE II						PHASE III															
			Pre Construction					Construction/ Establishment						Operation and Maintenance															
			CMSWM Facility					Landfill						General operations at the disposal facilities						Landfill			Composting			RDF		Biomethanation	Incineration
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	32	33
Social	Economy	Creation of new economic activities and status						*	*					*	*	*	*			*	*							*	*	*	*
		Commercial value of properties					*	*					*	*	*		*	*				*			*			*		*	*
		Conflict due to negotiation and/ compensation payments		*	*	*	*															*			*						
		Generation of temporary and permanent jobs						*	*					*	*		*					*	*		*	*					
		Effect on crops																					*			*					
	Education	Training in new technologies and new skills to workers						*	*	*				*				*		*		*			*			*		*	*
	Public Order	Political conflicts		*			*							*				*				*			*			*		*	

			PHASE I					PHASE II						PHASE III																
			Pre Construction					Construction/ Establishment						Operation and Maintenance																
			CMSWM Facility					Landfill						General operations at the disposal facilities						Landfill			Composting			RDF		Biomethanation	Incineration
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	32	33
		Unrest, demonstrations & social conflicts		*			*					*		*			*	*				*	*		*	*					
	Infrastructure and Services	Conflicts with projects of urban, commercial or industrial development												*	*	*	*	*													
	Security and Safety	Road and fire accidents												*	*		*					*		*	*			*	*	*	
	Health	Temporary				*								*				*				*	*	*	*	*		*		*	
		Chronic												*				*				*	*	*	*	*		*		*	
	Cultural	Land use and quality						*										*				*			*						
		Recreation				*	*	*					*					*				*									
		Aesthetics and human interest												*	*		*					*	*		*	*					*
		Cultural status										*	*	*	*		*					*			*						

Note:

1. Above table represents a model for likely impacts, which will have to be arrived at on a case-to-case basis considering VECs and significance analysis (Ref Section 2.9).

2. Project activities are shown as indicative. However, in Form 1 (application for EIA Clearance), for any question for which answer is 'Yes', then the corresponding activity shall reflect in project activities. Similarly 'parameters'/'factors' will also be changed within a component in order to reflect the target species of prime concern in the receiving local environment.

4.3.5 Testing the Significance of Impacts

The following set of conditions may be used as the checklist for testing the significance of the impacts and also to provide information in Column IV of Form 1.

- Will there be a large change in environmental conditions?
- Will new features be out-of-scale with the existing environment?
- Will the effect be unusual in the area or particularly complex?
- Will the effect extend over a large area?
- Will there be any potential for trans-frontier impact?
- Will many people be affected?
- Will many receptors of other types (fauna and flora, businesses, facilities) be affected?
- Will valuable or scarce features or resources be affected?
- Is there a risk that environmental standards will be breached?
- Is there a risk that protected sites, areas, and features will be affected?
- Is there a high probability of the effect occurring?
- Will the effect continue for a long time?
- Will the effect be permanent rather than temporary?
- Will the impact be continuous rather than intermittent?
- If it is intermittent will it be frequent rather than rare?
- Will the impact be irreversible?
- Will it be difficult to avoid, or reduce or repair or compensate for the effect?

For each "Yes" answer in column 3, the nature of effects and reasons for it should be recorded in the column 4. The questions are designed so that a "Yes" answer in column 3, will generally point towards the need for analyzing for the significance and requirement for conducting impact assessment for the effect.

4.3.6 Terms of reference for EIA studies

ToR for EIA studies in respect of the CMSWMF project may include, but not limited to the following:

1. Executive summary of the project – a *prima facie* idea of the objectives of the proposal, use of resources, justification, *etc.* In addition, it should provide a compilation of EIA report including EMP and the post-project monitoring plan in brief.

Project description

2. Justification for selecting the design period and capacities of waste processing facilities (recovery, treatment and disposal).

3. Land requirement for the project including its break up for various purposes, its availability and optimization.
4. Details on each unit in the facility describing its operations.
5. Details on the waste collection system – compliance to the statutory requirements
6. Details on site investigations – topographical surveys, geotechnical investigations (soil bearing capacity, permeability, *etc*).
7. Details of the proposed solid waste management system covering following:
   - Coverage area for collection of MSW including ULBs, if any
   - Population projections
   - Current waste generation rates and projections
   - Expected quantity of MSW generation
   - Current quantity of MSW collection
   - Physical and chemical characteristics of MSW
   - Details on MSW collection network
   - Transportation of MSW – type of vehicles, frequency of transportation, distance of transportation
   - Details of bio-medical waste and hazardous industrial waste generation in the serving area and their existing segregation and handling system
   - Details on existing accumulated MSW at disposal sites
   - Details on protocol for scientific renovation of existing landfill/disposal sites or scientific capping of landfills. Provide detailed project reports with findings of the field investigations on possible contamination, *etc*. engineering designs and specifications
   - Details on proposed recovery, treatment and disposal mechanism.
   - Details on compliance to MSW rules
   - Details on process flow diagram and specific operational features
   - List of plant and equipment to be set up and vehicles to be used with clear description of their environmental implication (emission, noise level, dust level, leachate generation, etc.)
   - Details of infrastructure facilities including stormwater drainage
   - Source of water and electric power
   - Precaution for avoiding unwanted material such as bio-medical waste
   - Details of safety measures for health and environment
8. Details on proposed monitoring protocol and laboratory facilities for routine sampling and analysis.
9. Details of design capacities of the storage facilities for recovered materials and specific features
10. Specific details on leachate generation rates, collection, treatment and disposal
11. Details of the landfill operation – filling, layers, equipment, compaction levels, cross-checking mechanism, stability considerations, trouble shooting mechanism, etc.
12. Details of proposed monitoring wells, locations, frequency of monitoring, parameters *etc*.
13. Proposed financial model, creation of fund for future liabilities till 30 years of post closure including monitoring, *etc*.
14. Fire fighting, safety and health protection measure in the project design and operations

15. In case of expansion projects, compliance with the issued EIA clearance conditions and 'consent to operate' conditions of existing facility may be described besides legal cases against the existing project, if any.
16. Any litigation pending against the project and /or any direction /order passed by any Court of Law related to the environmental pollution and impacts in the last two years, if so, details thereof.

Description of the environment

17. The study area shall be up to a distance of 5 km from the boundary of the proposed project site.
18. A map indicating the location of MSW facility, township and nearest villages, industries and distance from the facility shall be included.
19. Location of the project site, nearest habitats as well as landfill to be demarcated on the toposheet (1: 50000 scale).
20. Landuse for the study area based on satellite imagery including location of specific sensitivities such as national parks / wildlife sanctuary / sensitive areas, *etc*.
21. Topography details of the project area.
22. Demography details of all the villages (population, list of existing industries, *etc*.) falling within study area.
23. Baseline data of the study area w.r.t. different components of environment viz. air, noise, water, land, and biology and socio-economic as per the guidance given in Section 4.4.2. Actual monitoring of baseline environmental components shall be strictly according to the parameters prescribed in the ToR after considering the proposed coverage of parameters by the proponent in draft ToR and shall commence after finalization of ToR by the competent Authority.
24. Geological features and geo-hydrological status of the facility.
25. Details on groundwater such as water depth, water quality, drainage pattern, yield potential, *etc*.
26. Details on surface water quality of nearby water sources and other surface drains for the parameters such as suspended solids*, BOD*, COD*, heavy metals*, pH*, chlorides*, dissolved solids*, nitrate*, zinc*, sulphate*, phenolic compounds*, *etc*. (* - as applicable)
27. Details on existing ambient air quality and expected emissions for PM10, PM 2.5, CH_4, fly index test, SO_2*, NOx*, *etc*.) and evaluation of the adequacy of the proposed pollution control devices to meet standards for point sources and to meet AAQ standards. (* - as applicable)
28. Details on noise levels at sensitive/commercial receptors.
29. Site-specific meteorological data such as wind speed, wind direction, relative humidity, temperature, rainfall, *etc*.
30. One season site-specific meteorological data.
31. Baseline monitoring network.
32. Ecological status (terrestrial and aquatic) of the study area such as habitat type and quality, species, diversity, rarity, fragmentation, ecological linkage, age, abundance, *etc*.

33. If any incompatible land use attributes fall within the study area, proponent shall describe the sensitivity (distance, area and significance) and propose additional points based on significance for review and acceptance by the EAC/SEAC. Incompatible landuse attributes include:

    - Public water supply areas from rivers/surface water bodies, from ground water
    - Scenic areas/tourism areas/hill resorts
    - Religious places, pilgrim centers that attract over 10 lakh pilgrims a year
    - Protected tribal settlements (notified tribal areas where industrial activity is not permitted)
    - Monuments of national significance, World Heritage Sites
    - Cyclone, Tsunami prone areas (based on last 25 years);
    - Airport areas
    - Any other feature as specified by the State or local government and other features as locally applicable, including prime agricultural lands, pastures, migratory corridors, *etc*.

34. If ecologically sensitive attributes fall within the study area, proponent shall describe the sensitivity (distance, area and significance) and propose the additional points based on significance for review and acceptance by the EAC/SEAC. Ecological sensitive attributes include:

    - National parks
    - Wild life sanctuaries
    - Tiger reserve/elephant reserve/turtle nesting ground
    - Mangrove area
    - Wetlands
    - Reserved and Protected forests
    - Any other closed/protected area under the Wild Life (Protection) Act, 1972, any other area locally applicable
    - Any other eco-sensitive areas

35. If the location falls in Valley, specific issues connected to the natural resources management shall be studied and presented.

36. If the location falls in CRZ area: A CRZ map duly authenticated by one of the authorized agencies demarcating LTL, HTL, CRZ area, location of the project and associate facilities w.r.t. CRZ, coastal features such as mangroves, if any.

    - Provide the CRZ map in 1:10000 scale in general cases and in 1:5000 scale for specific observations.
    - Proposed site for disposal of dredged material and environmental quality at the point of disposal/impact areas.
    - Fisheries study should be done w.r.t. Benthos and Marine organic material and coastal fisheries.

Anticipated environmental impacts and mitigation measures

37. Anticipated generic environmental impacts due to this project are indicated in Table 4-2, which may be evaluated for significance and based on corresponding likely impacts VECs may be identified. Baseline studies may be conducted for all these VECs and likely impacts will have to be assessed for their magnitude in order to identify mitigation measures (please refer Chapter 4 of the manual for guidance).

38. Tools as given in Section 4.4.3 may be referred for the appropriate assessment of environmental impacts and same may be submitted in draft ToR for consideration and approval by EAC/SEAC.
39. While identifying the likely impacts, also include the following for analysis aof significance and required mitigation measures:
    - Impacts due to transportation of waste and transport system
    - impacts due to leachate generation on groundwater, drainage and surroundings
    - impacts due to breeding of domestic flies and their maggots
    - impacts due to methane (CH_4) and carbon-dioxide (CO_2) gas emissions from the existing waste on AAQ
    - impacts on community health effects
    - impacts due to fire hazards in waste dump
    - impacts due to noise
40. For identifying the mitigation measures, please refer Chapter III for source control and treatment. Besides typical mitigation measures which may also be considered are discussed in Table 4-5.
41. Proposed measures for occupational safety and health of the workers.
42. Scheme for stormwater management within and around the proposed facility.
43. Incase of likely impacts from the proposed facility on the surrounding reserve forests, Plan for the conservation of wild fauna in consultation with the State Forest Department.
44. Action plan for greenbelt development including the details of species, width of plantation, planning schedule, *etc*.

Analysis of alternative resources and technologies

45. Comparison of alternate sites considered and the reasons for selecting the proposed site. Conformity of the site with the prescribed guidelines in terms of CRZ, river, highways, railways, etc.
46. Details of improved technologies and better operating practices.

Environmental monitoring program

47. Monitoring of qualitative environmental parameters at source.
48. Monitoring of pollutants at receiving environment for all the appropriate notified parameters for air quality, groundwater, surface water, *etc*.
49. Specific programme to monitor safety and health protection of workers. Specific reference to improving rag pickers quality of life, health concerns, *etc*.
50. Programme for monitoring of pathogenic density and fly index test.
51. Appropriate monitoring network has to be designed and proposed, to assess the possible residual impacts on VECs.
52. Yearly monitoring of the ground water quality in and around the MSW facility at about 25 monitoring stations to record fluctuations and to report.
53. Details of in-house monitoring capabilities and the recognized agencies proposed for conducting the monitoring.

Additional studies

54. Details on welfare measures for rag pickers, personal involved in MSW collection and processing including health checkups.
55. Details on risk assessment and damage control during different phases of the project and proposed safeguard measures.
56. Details on socio-economic development activities such as commercial property values, generation of jobs, education, social conflicts, cultural status, accidents, *etc*.
57. Proposed plan to handle the socio-economic influence on the local community. The plan should include quantitative dimension as far as possible.
58. Points identified in the public hearing and commitment of the project proponent to the same. Detailed action plan addressing the issues raised, and the details of necessary allocation of funds.

Environmental management plan

59. Administrative and technical organizational structure to ensure proposed post-project monitoring programme for approved mitigation measures.
60. EMP devised to mitigate the adverse impacts of the project should be provided along with item-wise cost of its implementation (Capital and recurring costs).
61. Allocation of resources and responsibilities for plan implementation.
62. Details of the emergency preparedness plan and on-site and off-site disaster management plan.

Note:

Above points shall be adequately addressed in the EIA report at corresponding chapters, in addition to the contents given in the reporting structure (Table: 4-6).

4.4 Environmental Impact Assessment

The generic approach for accomplishing EIA studies is shown in Figure 4.3. Each stage is discussed, in detail in subsequent sections.

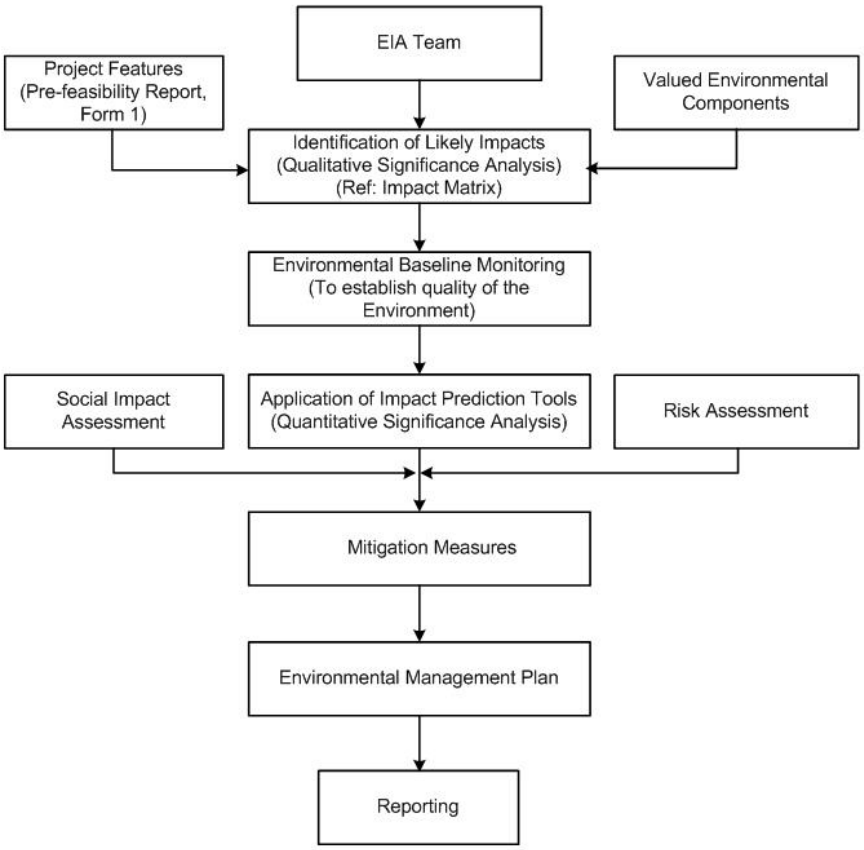

Figure 4-3: Approach for EIA Study

4.4.1 EIA team

The success of a multi-functional activity like an EIA primarily depends on constitution of a right team at the right time (preferable at the initial stages of an EIA) in order to assess the significant impacts (direct, indirect as well as cumulative impacts).

The professional Team identified for a specific EIA study should consist of qualified and experienced professionals from various disciplines in order to address the critical aspects identified for the specific project. Based on the nature and the environmental setting, following professionals may be identified for EIA studies:

- Environmental management specialist/regulator
- Air and noise quality
- Toxicology/Occupational health
- Geology/geo-hydrology
- Ecologist
- Chemical engineer
- Transportation Specialist
- Safety and health specialist
- Social scientist, *etc.*

4.4.2 Baseline quality of the environment

EIA Notification 2006 specifies that an EIA Report should contain a description of the existing environment that would be or might be affected directly or indirectly by the

proposed project. Environmental Baseline Monitoring (EBM) is a very important stage of EIA. On one hand EBM plays a very vital role in EIA and on the other hand it provides feedback about the actual environmental impacts of a project. EBM, during the operational phase, helps in judging the success of mitigation measures in protecting the environment. Mitigation measures, in turn are used to ensure compliance with environmental standards, and to facilitate the needed project design or operational changes.

Description of the existing environment should include natural, cultural, socio-economic systems and their interrelationships. The intention is not to describe all baseline conditions, but to focus the collection and description of baseline data on those VECs that are important and are likely to be affected by the proposed industrial activity.

4.4.2.1 Objectives of EBM in EIA context

The term 'baseline' refers to conditions existing before development. EBM studies are carried out to:

- identify environmental conditions which might influence project design decisions (*e.g.*, site layout, structural or operational characteristics);
- identify sensitive issues or areas requiring mitigation or compensation;
- provide input data to analytical models used for predicting effects;
- provide baseline data against which the results of future monitoring programs can be compared.

At this stage of EIA process, the EBM is primarily discussed in the context of first purpose wherein the feedback from EBM programs may be used to:

- determine available assimilative capacity of different environmental components within the designated impact zone and whether more or less stringent mitigation measures are needed
- improve predictive capability of EIAs

There are many institutional, scientific, quality control, and fiscal issues that must be addressed in implementation of an environmental monitoring program. Careful consideration of these issues in the design and planning stages will help avoid many of the pitfalls associated with environmental monitoring programs.

4.4.2.2 Environmental monitoring network design

Monitoring refers to the collection of data through a series of repetitive measurements of environmental parameters (or, more generally, to a process of systematic observation). Design of the environmental quality monitoring programme design depends up on the monitoring objectives specified for the selected area of interest. Types of monitoring and network design considerations are discussed in **Annexure X**.

4.4.2.3 Baseline data generation

List of important physical environmental components and indicators of EBM are given in Table 4-3.

Table 4-3: List of Important Physical Environment Components and Indicators of EBM

Environmental Component	Environmental Indicators
Climatic variables	▪ Rainfall patterns – mean, mode, seasonality ▪ Temperature patterns ▪ Extreme events ▪ Climate change projections ▪ Prevailing wind - direction, speed, anomalies ▪ Relative humidity ▪ Stability conditions and mixing height, *etc.*
Topography	▪ Slope form ▪ Landform and terrain analysis ▪ Specific landform types, *etc.*
Drainage	▪ Surface hydrology ▪ Natural drainage pattern and network ▪ Rainfall runoff relationships ▪ Hydrogeology ▪ Groundwater characteristics – springs, *etc*.
Soil	▪ Type and characteristics ▪ Porosity and permeability ▪ Sub-soil permeability ▪ Run-off rate ▪ Infiltration capacity ▪ Effective depth (inches/centimeters) ▪ Inherent fertility ▪ Suitability for method of sewage disposal, *etc.*
Geology	▪ Underlying rock type, texture ▪ Surgical material ▪ Geologic structures (faults, shear zones, *etc*.) ▪ Geologic resources (minerals, *etc*.)
Water	▪ Raw water availability ▪ Water quality ▪ Surface water (rivers, lakes, ponds, gullies) – quality, water depths, flooding areas, etc. ▪ Ground water – water table, local aquifer storage capacity, specific yeild, specific retention, water level depths and fluctuations, etc. ▪ Coastal ▪ Floodplains ▪ Wastewater discharges ▪ Waste discharges, *etc.*
Air	▪ Ambient ▪ Respirable ▪ Airshed importance ▪ Odour levels, *etc.*
Noise	▪ Identiyfing sources of noise ▪ Noise due to traffic/transportation of vehicles ▪ Noise due to heavy euipment operations ▪ Duration and variations in noise over time, *etc.*
Coastal dynamics and morphology	▪ Wave patterns ▪ Currents ▪ Shoreline morphology – near shore, foreshore

Environmental Component	Environmental Indicators
	▪ Sediment – characteristics and transport, *etc.*
Biological	▪ Species composition of flora and fauna ▪ Flora – type, density, exploitation, etc. ▪ Fauna – distribution, abundance, rarity, migratory, species diversity, habitat requirements, habitat resilience, economic significance, comemrcial value, etc. ▪ Fisheries – migratory species, species with commercial/ recreational value, *etc.*
Landuse	▪ Landuse pattern, *etc.*

Guidance for assessment of baseline components and attributes describing sampling network, sampling frequency, method of measurement is given in **Annexure XI**.

Infrastructure requirements for EBM

In addition to devising a monitoring network design and monitoring plans/program, it is also necessary to ensure adequate resources in terms of staffing, skills, equipment, training, budget, *etc*., for its implementation. Besides assigning institutional responsibility, reporting requirements, QA/QC plans and its enforcement capability are essential. A monitoring program that does not have an infrastructural support and QA/QC component will have little chance of success.

Defining data statistics/analyses requirements

The data analyses to be conducted are dictated by the objectives of the environmental monitoring program. Statistical methods used to analyze data should be described in detail prior to data collection. This is important because repetitive observations are recorded in time and space. Besides, the statistical methods could also be chosen so that uncertainty or error estimates in the data can be quantified. For *e.g.,* statistical methods useful in an environmental monitoring program include: 1) frequency distribution analysis; 2) analysis of variance; 3) analysis of covariance; 4) cluster analysis; 5) multiple regression analysis; 6) time series analysis; 7) the application of statistical models.

Use of secondary data

The EBM program for EIA can at best address temporal and/or spatial variations limited to a limited extent because of cost implications and time limitations. Therefore analysis of all available information or data is essential to establish the regional profiles. So all the relevant secondary data available for different environmental components should be collated and analyzed.

To facilitate stakeholders, IL&FS Ecosmart Ltd., has made an attempt to compile the list of information required for EIA studies and sources of secondary data, which are given in **Annexure XIIA** and **Annexure XIIB**.

4.4.3 Impact prediction tools

The scientific and technical credibility of an EIA relies on the ability of EIA practitioners to estimate the nature, extent, and magnitude of change in environmental components that may result from project activities. Information about predicted changes is needed for assigning impact significance, prescribing mitigation measures, and designing & developing EMPs and monitoring programs. The more accurate the predictions, the more confident the EIA practitioner will be in prescribing specific measures to eliminate or minimize the adverse impacts of development project.

Choice of models/methods for impact predictions in respect to air, noise, water, land, biological and socio-economic environment are tabulated in **Annexure XIII**.

4.4.4 Significance of the impacts

Evaluating the significance of environmental effects is perhaps the most critical component of impact analysis. The interpretation of significance bears directly on the subsequent EIA process and also during prior environmental clearance on project approvals and condition setting. At an early stage, it also enters into screening and scoping decisions on what level of assessment is required and which impacts and issues will be addressed.

Impact significance is also a key to choosing among alternatives. In total, the attribution of significance continues throughout the EIA process, from scoping to EIS review, in a gradually narrowing "cone of resolution" in which one stage sets up the next. But at this stage it is the most important as better understanding and quantification of impact significance is required.

One common approach is based on determination of the significance of predicted changes in the baseline environmental characteristics and compares these w.r.t regulatory standards, objective criteria and similar 'thresholds' as eco-sensitivity, cultural /religious values. Often, these are outlined in guidance. A better test proposed by the CEAA (1995) is to determine if 'residual' environmental effects are adverse, significant, and likely (given under). But at this stage, the practice of formally evaluating significance of residual impacts, *i.e.*, after predicting the nature and magnitude of impacts based on before-versus-after-project comparisons, and identifying measures to mitigate these effects is not being followed in a systematic way.

i. Step 1: Are the environmental effects adverse?

Criteria for determining if effects are "adverse" include:

- effects on biota health
- effects on rare or endangered species
- reductions in species diversity
- habitat loss
- transformation of natural landscapes
- effects on human health
- effects on current use of lands and resources for traditional purposes by aboriginal persons
- foreclosure of future resource use or production

ii. Step 2: Are the adverse environmental effects significant?

Criteria for determining 'significance' are to judge that the impacts:

- are extensive over space or time
- are intensive in concentration or proportion to assimilative capacity
- exceed environmental standards or thresholds
- do not comply with environmental policies, landuse plans, sustainability strategy
- adversely and seriously affect ecologically sensitive areas
- adversely and seriously affect heritage resources, other landuses, community lifestyle and/or indigenous peoples traditions and values

iii. Step 3: Are the significant adverse environmental effects likely?

Criteria for determining 'likelihood' include:

- probability of occurrence, and
- scientific uncertainty

4.5 Social Impact Assessment

Social Impact Assessment (SIA) is an instrument used to analyze social issues and solicit stakeholder views for the design of projects. SIA helps in making the project responsive to social development concerns, including options that enhance benefits for poor and vulnerable people while mitigating risk and adverse impacts. It analyzes distributional impacts of intended project benefits on different stakeholder groups, and identifies differences in assets and capabilities to access the project benefits.

The scope and depth of SIA should be determined by the complexity and importance of the issues studied, taking into account the skills and resources available. SIA should include studies related to involuntary resettlement, compulsory land acquisition, impact of imported workforces, job losses among local people, damage to sites of cultural, historic or scientific interest, impact on minority or vulnerable groups, child or bonded labour, use of armed security guards. However, SIA may primarily include the following:

Description of the socio-economic, cultural and institutional profile

Conduct a rapid review of available sources of information to describe the socio-economic, cultural and institutional interface in which the project operates.

Socio-economic and cultural profile: Describe the most significant social, economic and cultural features that differentiate social groups in the project area. Describe their different interests in the project, and their levels of influence. Explain specific effects that the project may have on the poor and underprivileged. Identify any known conflicts among groups that may affect project implementation.

Institutional profile: Describe the institutional environment; consider both the presence and function of public, private and civil society institutions relevant to the operation. Are there important constraints within existing institutions e.g. disconnect between institutional responsibilities and the interests and behaviors of personnel within those institutions? Or are there opportunities to utilize the potential of existing institutions, e.g. private or civil society institutions, to strengthen implementation capacity.

Legislative and regulatory considerations

To review laws and regulations governing the project's implementation and access of poor and excluded groups to goods, services and opportunities provided by the project. In addition, review the enabling environment for public participation and development planning. SIA should build on strong aspects of legal and regulatory systems to facilitate program implementation and identify weak aspects while recommending alternative arrangements.

Key social issues

SIA provides baseline information for designing the social development strategy. The analysis should determine the key social and institutional issues which affect the project objectives; identify the key stakeholder groups in this context and determine how relationships between stakeholder groups will affect or be affected by the project; and identify expected social development outcomes and actions proposed to achieve those outcomes.

Data collection and methodology

Describe the design and methodology for social analysis. In this regard:

- Build on existing data;
- Clarify the units of analysis for social assessment: intra-household, household level, as well as communities/settlements and other relevant social aggregations on which data is available or will be collected for analysis;
- Choose appropriate data collection and analytical tools and methods, employing mixed methods wherever possible; mixed methods include a mix of quantitative and qualitative methods.

Strategy to achieve social development outcomes

Identify the likely social development outcomes of the project and propose a Social development strategy, including recommendations for institutional arrangements to achieve them, based on the findings of the social assessment. The social development strategy could include measures that:

- strengthen social inclusion by ensuring both poor and excluded groups and intended beneficiaries are included in the benefit stream; offer access to opportunities created by the project
- empower stakeholders through their participation in the design and implementation of the project, their access to information, and their increased voice and accountability (*i.e*. a participation framework); and
- enhance security by minimizing and managing likely social risks and increasing the resilience of intended beneficiaries and affected persons to socioeconomic shocks

Implications for analysis of alternatives

Review proposed approaches for the project, and compare them in terms of their relative impacts and social development outcomes. Consider what implications the findings of the social assessment might have on those approaches. Should some new components be added to the approach, or other components be reconsidered or modified?

If SIA and consultation processes indicate that alternative may have better development outcomes, such alternatives should be described and considered, along with the likely budgetary and administrative effects these changes might have.

Recommendations for project design and implementation arrangements

Provide guidance to project management and other stakeholders on how to integrate social development issues into project design and implementation arrangements. As much as possible, suggest specific action plans or implementation mechanisms to address relevant social issues and potential impacts. These can be developed as integrated or separate action plans, for example, as Resettlement Action Plans, Indigenous Peoples Development Plans, Community Development Plans, *etc*.

Developing a monitoring plan

Through SIA process, a framework for monitoring and evaluation should be developed. To the extent possible, this should be done in consultation with key stakeholders, especially beneficiaries and affected people.

The framework shall identify expected social development indicators, establish benchmarks, and design systems and mechanisms for measuring progress and results related to social development objectives. The framework shall identify organizational responsibilities in terms of monitoring, supervision, and evaluation procedures. Wherever possible, participatory monitoring mechanisms shall be incorporated. The framework should establish:

- A set of monitoring indicators to track the progress achieved. The benchmarks and indicators should be limited in number, and should combine both quantitative and qualitative types of data. The indicators for outputs to be achieved by the social development strategy should include indicators to monitor the process of stakeholder participation, implementation and institutional reform
- Indicators to monitor social risk and social development outcomes; and indicators to monitor impacts of the project's social development strategy. It is important to suggest mechanisms through which lessons learned from monitoring and stakeholder feedback can result in changes to improve the operation of the project. Indicators should be of such a nature that results and impacts can be disaggregated by gender and other relevant social groups
- Define transparent evaluation procedures. Depending on context, these may include a combination of methods, such as participant observation, key informant interviews, focus group discussions, census and socio-economic surveys, gender analysis, Participatory Rural Appraisal (PRA), Participatory Poverty Assessment (PPA) methodologies, and other tools. Such procedures should be tailored to the special conditions of the project and to the different groups living in the project area; Estimate resource and budget requirements for monitoring and evaluation activities, and a description of other inputs (such as institutional strengthening and capacity building) needed to be carried out.

4.6 Risk Assessment

Industrial accidents results in great personal and financial loss. Managing these accidental risks in today's environment is the concern of every sector including CMSWM

facilities, because either real or perceived incidents can quickly jeopardize the financial viability of a business. Many facilities involve various manufacturing processes that have the potential for accidents which may be catastrophic to the plant, work force, environment, or public.

The main objective of risk assessment study is to propose a comprehensive but simple approach to carry out risk analysis and conducting feasibility studies for industries, planning and management of industrial prototype hazard analysis study in Indian context.

Risk analysis and risk assessment should provide details on Quantitative Risk Assessment (QRA) techniques used world-over to determine risk posed to people who work inside or live near hazardous facilities, and to aid in preparing effective emergency response plans by delineating a Disaster Management Plan (DMP) to handle onsite and offsite emergencies. Hence, QRA is an invaluable method for making informed risk-based process safety and environmental impact planning decisions, as well as being fundamental to any decision while siting a facility. QRA whether, site-specific or risk-specific for any plant is complex and needs extensive study that involves process understanding, hazard identification, consequence modeling, probability data, vulnerability models/data, local weather and terrain conditions and local population data. QRA may be carried out to serve the following objectives.

- Identification of safety areas
- Identification of hazard sources
- Generation of accidental release scenarios for escape of hazardous materials from the facility
- Identification of vulnerable units with recourse to hazard indices
- Estimation of damage distances for the accidental release scenarios with recourse to Maximum Credible Accident (MCA) analysis
- Hazard and Operability studies (HAZOP) in order to identify potential failure cases of significant consequences
- Estimation of probability of occurrences of hazardous event through fault tree analysis and computation of reliability of various control paths
- Assessment of risk on basis of above evaluation against the risk acceptability criteria relevant to the situation
- Suggest risk mitigation measures based on engineering judgment, reliability and risk analysis approaches
- Delineation / up-gradation of DMP
- Safety Reports: with external safety report/ occupational safety report

The risk assessment report may cover the following in terms of the extent of damage with resource to MCA analysis and delineation of risk mitigations measures with an approach to DMP.

- Hazard identification – identification of hazardous activities, hazardous materials, past accident records, *etc*.
- Hazard quantification – consequence analysis to assess the impacts
- Risk presentation
- Risk mitigation measures
- DMPs

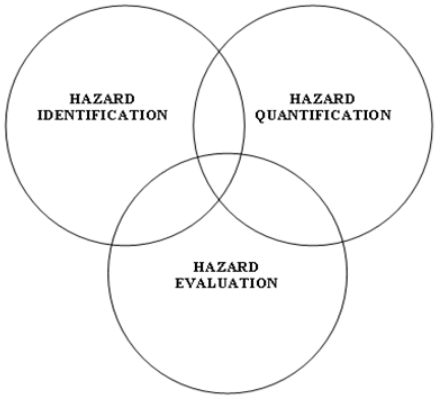

Figure 4-4: Risk Assessment – Conceptual Framework

Methods of risk prediction should cover all the design intentions and operating parameters to quantify risk in terms of probability of occurrence of hazardous events and magnitude of its consequence. Table 4-4 shows the predictive models for risk assessment.

Table 4-4: Choice of Models for Impact Predictions: Risk Assessment

Name	Application	Remarks
EFFECT	Consequence Analysis for Visualization of accidental chemical release scenarios & its consequence	Heat load, press wave & toxic release exposure neutral gas dispersion
WHAZAN	Consequence Analysis for Visualization of accidental chemical release scenarios & its consequence	
EGADIS	Consequence Analysis for Visualization of accidental chemical release scenarios & its consequence	Dense gas dispersion
HAZOP and Fault Tree Assessment	For estimating top event probability	Failure frequency data is required
Pathways reliability and protective system hazard analysis	For estimating reliability of equipments and protective systems	Markov models
Vulnerability Exposure models	Estimation of population exposure	Uses probit equation for population exposure
F-X and F-N curves	Individual / Societal risks	Graphical Representation

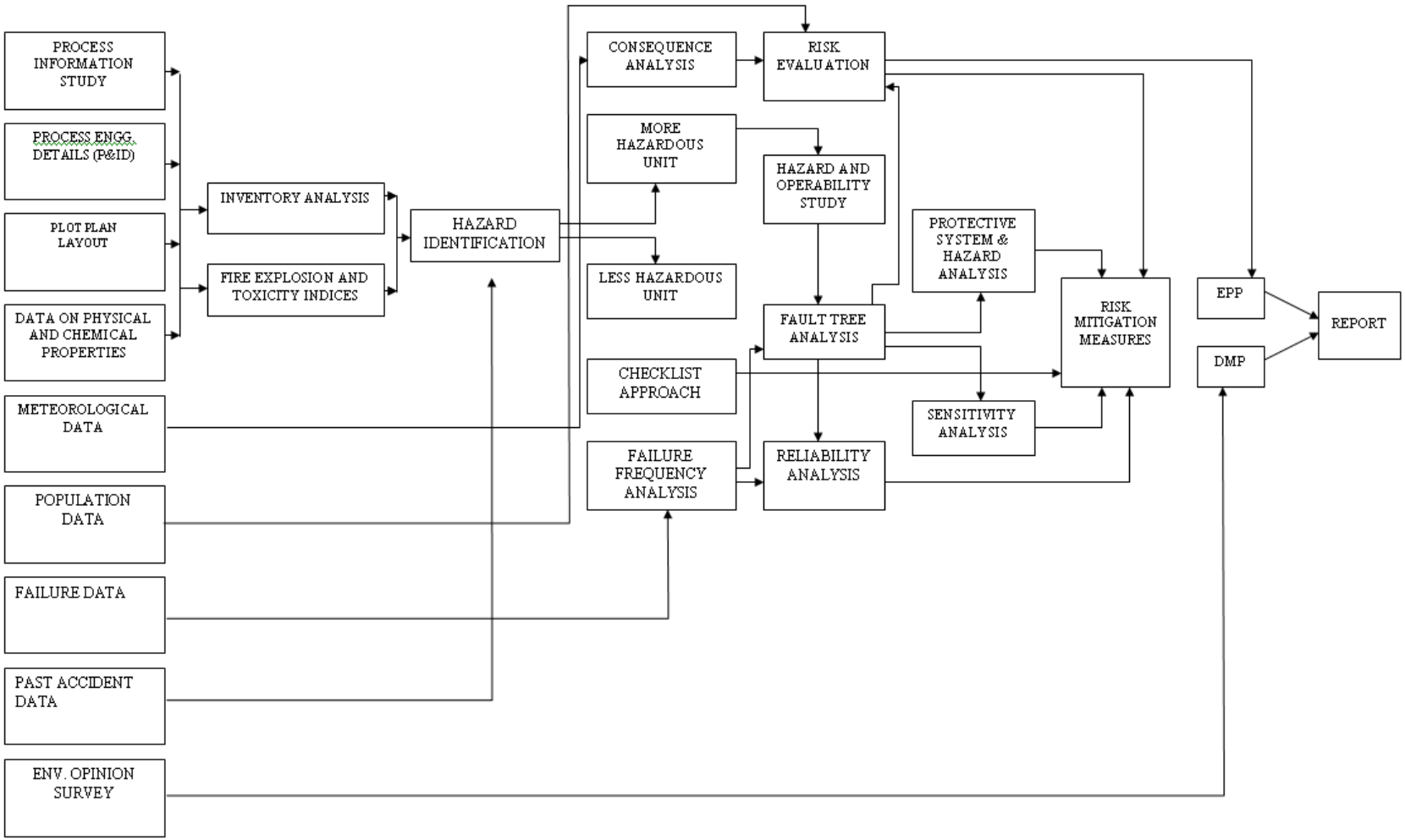

Figure 4-5: Comprehensive Risk Assessment - At a Glance

4.7 Mitigation Measures

The purpose of mitigation is to identify measures that safeguard the environment and the community affected by the proposal. Mitigation is both a creative and practical phase of the EIA process. It seeks to find the best ways and means of avoiding, minimizing and remedying impacts. Mitigation measures must be translated into action in right way and at the right time, if they are to be successful. This process is referred to as impact management and takes place during project implementation. A written plan should be prepared for this purpose, and should include a schedule of agreed actions. Opportunities for impact mitigation will occur throughout the project cycle.

4.7.1 Important considerations for mitigation methods

The responsibility of project proponents to 'internalize' the full environmental costs of development proposals is now widely accepted under "Polluter Pay" principle. In addition, many proponents have found that good design and impact management can result in significant savings applying the principles of cleaner production to improve their environmental performance.

- The predicted adverse environmental as well as social impacts for which mitigation measures are required should be identified and briefly summarized along with cross referencing them to the significance, prediction components of the EIA report or other documentation.
- Each mitigation measure should be briefly described w.r.t the impact of significances to which it relates and the conditions under which it is required (for example, continuously or in the event of contingencies). These should also be cross-referenced to the project design and operating procedures which elaborate on the technical aspects of implementing the various measures.
- Cost and responsibilities for mitigation and monitoring should be clearly defined, including arrangements for coordination among various authorities responsible for mitigation.
- The proponent can use the EMP to develop environmental performance standards and requirements for the project site as well as supply chain. An EMP can be implemented through EMS for the operational phase of the project.

Prior to selecting mitigation plans it is appropriate to study the mitigation alternatives for cost-effectiveness, technical and socio-political feasibility. Such mitigation measures could include:

- avoiding sensitive areas such as eco-sensitive area e.g. fish spawning areas, dense mangrove areas or areas known to contain rare or endangered species
- adjusting work schedules to minimize disturbance
- engineered structures such as berms and noise attenuation barriers
- pollution control devices such as scrubbers and electrostatic precipitators
- changes in fuel feed, manufacturing, process, technology use, or waste management practices, *etc.*

4.7.2 Hierarchy of elements of mitigation plan

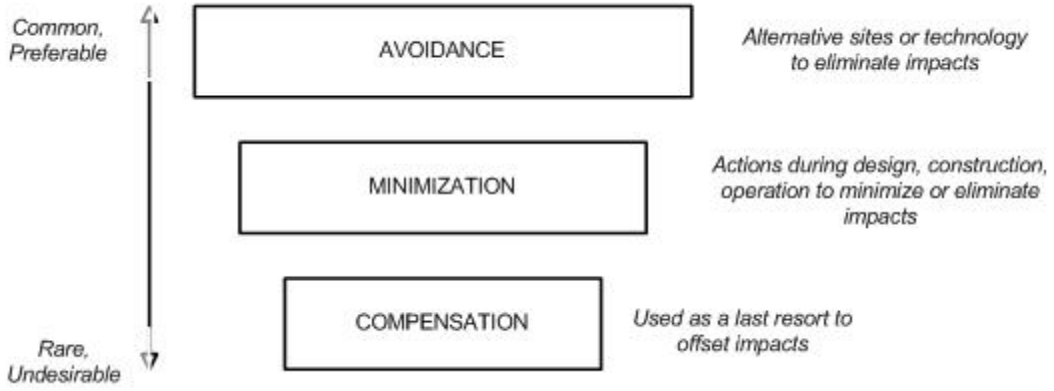

Figure 4-6: Elements of Mitigation

A good EIA practice requires technical understanding of relevant issues and the measures that work in such given circumstances: The priority of selection of mitigation measures should be in the order:

Step One: Impact avoidance

This step is most effective when applied at an early stage of project planning. It can be achieved by:

- not undertaking certain projects or elements that could result in adverse impacts
- avoiding areas that are environmentally sensitive
- putting in place the preventative measures to stop adverse impacts from occurring, for example, release of water from a reservoir to maintain a fisheries regime

Step Two: Impact minimization

This step is usually taken during impact identification and prediction to limit or reduce the degree, extent, magnitude, or duration of adverse impacts. It can be achieved by:

- scaling down or relocating the proposal
- redesigning elements of the project
- taking supplementary measures to manage the impacts

Step Three: Impact compensation

This step is usually applied to remedy unavoidable residual adverse impacts. It can be achieved by:

- rehabilitation of the affected site or environment, for example, by habitat enhancement and restocking fish
- restoration of the affected site or environment to its previous state or better, as typically required for mine sites, forestry roads and seismic lines
- replacement of the same resource values at another location. For example, by wetland engineering to provide an equivalent area to that lost to drainage or infill.

Important compensation elements

Resettlement Plans: Special considerations apply to mitigation of proposals that displace or disrupt people. Certain types of projects, such as reservoirs and irrigation schemes and public works, are known to cause involuntary resettlement. This is a contentious issue because it involves far more than re-housing people; in addition, income sources and access to common property resources are likely to be lost. Almost certainly, a resettlement plan will be required to ensure that no one is worse off than before, which may not be possible for indigenous people whose culture and lifestyle is tied to a locality. This plan must include the means for those displaced to reconstruct their economies and communities and should include an EIA of the receiving areas. Particular attention should be given to indigenous, minority and vulnerable groups who are at higher risk from resettlement.

In-kind compensation

When significant or net residual loss or damage to the environment is likely, in kind compensation is appropriate. As noted earlier, environmental rehabilitation, restoration or replacement have become standard practices for many proponents. Now, increasing emphasis is given to a broader range of compensation measures to offset impacts and assure the sustainability of development proposals. These include impact compensation 'trading', such as offsetting CO_2 emissions by planting forests to sequester carbon.

4.7.3 Typical mitigation measures

Choice of location for the developmental activity plays an important role in preventing adverse impacts on surrounding environment. Detailed guidelines on siting of industries are provided in Section 4.2. However, if the developmental activity produces any more impacts, mitigation measures should be taken.

Previous subsections of the Section 4.7 could be precisely summarized into following:

- Impacts from a developmental project could have many dimensions. As most of the direct impacts are caused by releases from developmental projects, often impact control at source is the best opportunity to either eliminate or mitigate the impacts. In other words, the best way to mitigate impacts is to prevent them from occurring. Choice of raw materials/technologies/processes which produce least impact would be one of the options to achieve it.
- In case, if it is not feasible to control impacts at source, various interventions to minimize the adverse impacts may be considered. These interventions, primarily aim at reducing the residual impacts on VECs of the receiving environment to the acceptable concentrations.
- Degree of control at source and external interventions differs from situation-to - situation and is largely governed by techno-economic feasibility. While the regulatory bodies stress for further source control (due to high reliability), the project proponents bargain for other interventions which may be relatively cost-effective than further control at source (in any case project authority is required to meet the project-specific standards by adopting the best practicable technologies. However, if the location demands further control at source, then the proponents are required to adopt further advanced control technologies *i.e*. towards best available control technologies). After having discussions with the project proponent, EAC/SEAC reaches to an agreed level

of source control + other interventions (together called as mitigation measures in the given context) that achieve the targeted protection levels for the VECs in the receiving environment. These levels will become the principle clearance conditions.

- Chapter 3 of this technical EIA Guidance Manual offers elaborate information on cleaner technologies, waste minimization opportunities, and control technologies for various kinds of polluting parameters that emanate from this developmental activity. This information may be used to draw appropriate control measures applicable at source.

The choice of interventions for mitigation of impacts may also be numerous and depend on various factors. Mitigation measures based on location-specific suitability and some other factors are discussed in sub-sections 4.7.1 and 4.7.2. A few other measures which may also be explored for mitigation of impacts are listed in Table 4-5.

Table 4-5: Typical Mitigation Measures

Impacts	Typical Mitigation Measures
Soil erosion	▪ Windscreens, maintenance, and installation of ground cover ▪ Installation of drainage ditches ▪ Runoff and retention ponds ▪ Minimize disturbances and scarification of the surface, *etc.*
Resources – fuel/construction material/ land use	▪ Optimization of resource use ▪ Availing resources with least impact – eco-efficiency options are applicable ▪ Availing the resources which could be replenished by natural systems, *etc.*
Deforestation	▪ Plant or create similar areas ▪ Initiate a tree planning program in other areas ▪ Donate land to conservationalist groups, *etc.*
Water pollution	▪ Conjunctive use of ground/surface water, to prevent flooding/water logging/depletion of water resources. Included are land use pattern, land filling, lagoon/reservoir/garland canal construction, and rainwater harvesting and pumping rate. ▪ Minimise flow variation from the mean flow ▪ Storing of oil wastes in lagoons should be minimised in order to avoid possible contamination of the ground water system. ▪ All effluents containing acid/alkali/organic/toxic wastes should be properly treated. ▪ Collection and treatment of lechate, sewage and storm water run-off ▪ Increased recycling of treated lechate ▪ Monitoring of ground waters ▪ Use of biodegradable or otherwise readily treatable additives ▪ Neutralization and sedimentation of wastewaters, where applicable ▪ Dewatering of sludges and appropriate disposal of solids ▪ Construction of liners before disposing waste ▪ In case of oil waste, oil separation before treatment and discharge into the environment ▪ By controlling discharge of sanitary sewage and industrial waste with suspended solids into the environment ▪ By avoiding the activities that increases erosion or that contributes nutrients to water (thus stimulating alga growth) ▪ For wastes containing high TDS, treatment methods include removal of liquid and disposal of residue by controlled landfilling to avoid

Impacts	Typical Mitigation Measures
	any possible leaching of the fills ▪ All surface runoffs around mines or quarries should be collected treated and disposed. ▪ Treated wastewater (such as sewage, industrial wastes, or stored surface runoffs) can be used as cooling water makeup. ▪ Wastewater carrying radioactive elements should be treated separately by means of de-watering procedures, and solids or brine should be disposed of with special care. ▪ Develop spill prevention plans in case of chemical discharges and spills ▪ Develop traps and containment system and chemically treat discharges on site, *etc.*
Air Pollution	▪ Attenuation of pollution/protection of receptor through green belts/green cover ▪ Use of particulate removal devices such as cyclones, setting chambers, scrubbers, electrostatic precipitators, bag houses, *etc*. ▪ Use of gas removal devices using absorption (liquid as a media), adsorption (molecular sieve), and catalytic converters ▪ Use of protected, controlled equipments such as oxygen masks, houston astrodome, *etc*. ▪ Control of stationary source emission (including evaporation, incineration, absorption, condensation, and material substitution) ▪ Dilution of odourant (dilution can change the nature as well as strength of an odour), odour counteraction or neutralise (certain pairs of odours in appropriate concentrations may neutralise each other), odour masking or blanketing (certain weaker malodours may be suppressed by a considerably stronger good odour). ▪ Regular monitoring of air polluting concentrations, *etc.*
Dust pollution	▪ Wetting of roadways to reduce traffic dust and reentrained particles ▪ Installation of windscreens to breakup the wind flow ▪ Burning of refuse on days when meteorological conditions provide for good mixing and dispersion ▪ Providing dust collection equipment at all possible points ▪ Maintaining dust levels within permissible limits ▪ Provision for masks when dust level exceeds, *etc.*
Noise pollution	▪ Use of heavy duty muffler systems on heavy equipment ▪ Limiting certain activities ▪ By using damping, absorption, dissipation, and deflection methods ▪ By using common techniques such as constructing sound enclosures, applying mufflers, mounting noise sources on isolators, and/or using materials with damping properties ▪ Performance specifications for noise represent a way to insure the procured item is controlled ▪ Use of ear protective devices. ▪ In case of steady noise levels above 85-dB (A), initiation of hearing conservation measures, *etc.*
Biological	▪ Installation of systems to discourage nesting or perching of birds in dangerous environments ▪ Increased employee awareness to sensitive areas, *etc.*
Social	▪ Health and safety measures for workers ▪ Development of traffic plan that minimizes road use by workers ▪ Upgradation of roads and intersections, *etc.*
Marine	▪ Water quality monitoring program

Impacts	Typical Mitigation Measures
environment	▪ Appropriate system to barges/workboats for collection of liquid/solid waste generated onboard ▪ Checking with the complainace conditions before discharging, *etc.*

4.8 Environmental Management Plan

A typical EMP shall be composed of the following:

1. summary of potential impacts of the proposal
2. description of recommended mitigation measures
3. description of monitoring programme to ensure compliance with relevant standards and residual impacts
4. allocation of resources and responsibilities for plan implementation
5. implementation schedule and reporting procedures
6. contingency plan when impacts are greater than expected

Summary of impacts: The predicted adverse environmental and social impacts for which mitigation measures are identified in earlier sections to be briefly summarized with cross referencing to the corresponding sections in the EIA report.

Description of mitigation measures: Each mitigation measure should be briefly described w.r.t the impact to which it relates and the conditions under which it is required. These should be accompanied by/referenced to, project design and operating procedures which elaborate on the technical aspects of implementing various measures.

Description of monitoring programme to ensure compliance with relevant standards and residual impacts: Environmental monitoring refers to compliance monitoring and residual impact monitoring. Compliance monitoring refers to meeting the project-specific statutory compliance requirements (Ref. Applicable National regulations as detailed in Chapter 3).

Residual impact monitoring refers to monitoring of identified sensitive locations with adequate number of samples and frequency. The monitoring programme should clearly indicate the linkages between impacts identified in the EIA report, measurement indicators, detection limits (where appropriate), and definition of thresholds that signal the need for corrective actions.

Allocation of resources and responsibilities for plan implementation: These should be specified for both the initial investment and recurring expenses for implementing all measures contained in the EMP, integrated into the total project costs, and factored into loan negotiation.

The EMP should contain commitments that are binding on the proponent in different phases of project implementation *i.e.,* pre-construction or site clearance, construction, operation, decommissioning.

Responsibilities for mitigation and monitoring should be clearly defined, including arrangements for coordination between various factors responsible for mitigation. Details should be provided w.r.t deployment of staff (detailed organogram), monitoring network design, parameters to be monitored, analysis methods, associated equipments, *etc*.

Implementation schedule and reporting procedures: The timing, frequency and duration of mitigation measure should be specified in an implementation schedule, showing links with overall project implementation. Procedures to provide information on progress and results of mitigation and monitoring measures should also be clearly specified.

Contingency Plan when the impacts are greater than expected: There shall be a contingency plan for attending the situations where the residual impacts are higher than expected. It is an imperative requirement for all the project Authorities to plan additional programmes to deal with the situation, after duly intimating the concerned local regulatory bodies.

4.9 Reporting

Structure of the EIA report (Appendix III of the EIA Notification), applicable for CMSWM facility is given in the Table 4.6. Each task prescribed in ToR shall be incorporated appropriately in the contents in addition to the contents described in the table.

Table 4-6: Structure of EIA Report

S.No	EIA Structure	Contents
1.	Introduction	▪ Purpose of the report ▪ Identification of project & project proponent ▪ Brief description of nature, size, location of the project and its importance to the country, region ▪ Scope of the study – details of regulatory scoping carried out (As per Terms of Reference)
2.	Project Description	Condensed description of those aspects of the project (based on project feasibility study), likely to cause environmental effects. Details should be provided to give clear picture of the following: ▪ Type of project ▪ Need for the project ▪ Location (maps showing general location, specific location, project boundary & project site layout) ▪ Size or magnitude of operation (incl. Associated activities required by or for the project) ▪ Proposed schedule for approval and implementation ▪ Technology and process description ▪ Project description including drawings showing project layout, components of project etc. Schematic representations of the feasibility drawings which give information important for EIA purpose ▪ Description of mitigation measures incorporated into the project to meet environmental standards, environmental operating conditions, or other EIA requirements (as required by the scope) ▪ Assessment of new & untested technology for the risk of

S.No	EIA Structure	Contents
		technological failure
3.	Description of the Environment	▪ Study area, period, components & methodology ▪ Establishment of baseline for VECs, as identified in the scope ▪ Base maps of all environmental components
4.	Anticipated Environmental Impacts & Mitigation Measures	▪ Details of Investigated Environmental impacts due to project location, possible accidents, project design, project construction, regular operations, final decommissioning or rehabilitation of a completed project ▪ Measures for minimizing and / or offsetting adverse impacts identified ▪ Irreversible and irretrievable commitments of environmental components ▪ Assessment of significance of impacts (Criteria for determining significance, Assigning significance) ▪ Mitigation measures
5.	Analysis of Alternatives (Technology & Site)	▪ Incase, the scoping exercise results in need for alternatives: ▪ Description of each alternative ▪ Summary of adverse impacts of each alternative ▪ Mitigation measures proposed for each alternative and selection of alternative
6.	Environmental Monitoring Program	▪ Technical aspects of monitoring the effectiveness of mitigation measures (incl. measurement methodologies, frequency, location, data analysis, reporting schedules, emergency procedures, detailed budget & procurement schedules)
7.	Additional Studies	▪ Public consultation ▪ Risk assessment ▪ Social impact assessment, R&R action plans
8.	Project Benefits	▪ Improvements in physical infrastructure ▪ Improvements in social infrastructure ▪ Employment potential –skilled; semi-skilled and unskilled ▪ Other tangible benefits
9.	Environmental Cost Benefit Analysis	▪ If recommended at the scoping stage
10.	EMP	▪ Description of the administrative aspects that ensures proper implementation of mitigative measures and their effectiveness monitored, after approval of the EIA
11.	Summary & Conclusion (This will constitute the summary of the EIA Report)	▪ Overall justification for implementation of the project ▪ Explanation of how, adverse effects have been mitigated
12.	Disclosure of Consultants engaged	▪ Names of the Consultants engaged with their brief resume and nature of Consultancy rendered

4.10 Public Consultation

Public consultation refers to the process by which the concerns of local affected people and others who have plausible stake in the environmental impacts of the project or activity are ascertained.

- Public consultation is not a decision taking process, but is a process to collect views of the people having plausible stake. If the SPCB/Public agency conducting public hearing is not convinced with the plausible stake, then such expressed views need not be considered.
- Public consultation involves two components, one is public hearing, and other one is inviting written responses/objections through Internet/by post, etc., by placing the summary of EIA report on the web site.
- All Category A and Category B1 projects require public hearing except the following:
  - Once prior environmental clearance is granted to an industrial estates/SEZs/EPZs *etc*., for a given composition (type and capacity) of industries, then individual units including common MSW facilities within the industrial estate if any, will not require public hearing
  - Expansion of roads and highways, which do not involve any further acquisition of land.
  - All building/construction projects/area development projects/townships
  - All Category B2 projects
  - All projects concerning national defense and security or involving other strategic considerations as determined by the Central Government
- Public hearing shall be carried out at the site or in its close proximity, district-wise, for ascertaining concerns of local affected people.
- Project proponent shall make a request through a simple letter to the Member–Secretary of the SPCB/UTPCC to arrange public hearing.
- Project proponent shall enclose with the letter of request, at least 10 hard copies and 10 soft copies of the draft EIA report including the summary EIA report in English and in the official language of the state/local language prepared as per the approved scope of work, to the concerned Authority.
- Simultaneously, project proponent shall arrange to send, one hard copy and one soft copy, of the above draft EIA report along with the summary EIA report to the following Authorities within whose jurisdiction the project will be located:
  - District magistrate/District Collector/Deputy Commissioner(s)
  - Zilla parishad and municipal corporation or panchayats union
  - District industries office
  - Urban local bodies (ULBs)/PRIs concerned/development authorities
  - Concerned regional office of the MoEF/SPCB
- Above mentioned Authorities except Regional office of MoEF shall arrange to widely publicize the draft EIA report within their respective jurisdictions requesting the interested persons to send their comments to the concerned regulatory authorities. They shall also make draft EIA report for inspection electronically or otherwise to the public during normal office hours till the public hearing is over.

- Concerned regulatory Authority (MoEF/SEIAA/UTEIA) shall display the summary of EIA report on its website and also make full draft EIA report available for reference at a notified place during normal office hours at their head office.
- SPCB or UTPCC concerned shall also make similar arrangements for giving publicity about the project within the State/UT and make available the summary of draft EIA report for inspection in select offices, public libraries or any other suitable location, *etc*. They shall also additionally make available a copy of the draft EIA report to the above five authorities/offices as mentioned above.
- The Member-Secretary of the concerned SPCB or UTPCC shall finalize the date, time and exact venue for the conduct of public hearing within seven days of the date of the receipt of the draft EIA report from the project proponent and advertise the same in one major National Daily and one Regional vernacular Daily/Official State Language.
- A minimum notice period of 30 (thirty) days shall be provided to the public for furnishing their responses.
- No postponement of the date, time, venue of the public hearing shall be undertaken, unless some untoward emergency situation occurs and then only on the recommendation of the concerned District Magistrate/District Collector/Deputy commissioner, the postponement shall be notified to the public through the same National and Regional vernacular dailies and also prominently displayed at all the identified offices by the concerned SPCB/UTPCC
- In the above exceptional circumstances fresh date, time and venue for the public consultation shall be decided by the Member-Secretary of the concerned SPCB/ UTPCC only in consultation with the District Magistrate/District Collector/Deputy commissioner and notified afresh as per the procedure.
- The District Magistrate/District Collector/Deputy commissioner or his or her representative not below the rank of an Additional District Magistrate assisted by a representative of SPCB/UTPCC, shall supervise and preside over the entire public hearing process.
- The SPCB/UTPCC shall arrange to video film the entire proceedings. A copy of the videotape or a CD shall be enclosed with the public hearing proceedings while forwarding it to the Regulatory Authority concerned.
- The attendance of all those who are present at the venue shall be noted and annexed with the final proceedings
- There shall be *no quorum* required for attendance for starting the proceedings
- Persons present at the venue shall be granted the opportunity to seek information or clarifications on the project from the proponent. The summary of the public hearing proceedings accurately reflecting all the views and concerns expressed shall be recorded by the representative of the SPCB/UTPCC and read over to the audience at the end of the proceedings explaining the contents in the local/vernacular language and the agreed minutes shall be signed by the District Magistrate/District Collector/Deputy commissioner or his or her representative on the same day and forwarded to the SPCB/UTPCC concerned.
- A statement of the issues raised by the public and the comments of the proponent shall also be prepared in the local language or the official State language, as the case may be, and in English and annexed to the proceedings.
- The proceedings of the public hearing shall be conspicuously displayed at the office of the Panchayats within whose jurisdiction the project is located, office of the concerned

Zilla Parishad, District Magistrate/District Collector/Deputy commissioner, and the SPCB or UTPCC. The SPCB or UTPCC shall also display the proceedings on its website for general information. Comments, if any, on the proceedings, may be sent directly to the concerned regulatory authorities and the proponent concerned.

- The public hearing shall be completed within a period of forty five days from date of receipt of the request letter from the proponent. Therefore the SPCB or UTPCC concerned shall send the public hearing proceedings to the concerned regulatory authority within eight days of the completion of the public hearing. Simultaneously, a copy will also be provided to the project proponent. The proponent may also directly forward a copy of the approved public hearing proceedings to the regulatory authority concerned along with the final EIA report or supplementary report to the draft EIA report prepared after the public hearing and public consultations incorporating the concerns expressed in the public hearing along with action plan and financial allocation, item-wise, to address those concerns.
- Upon receipt of the same, the Authority will place executive summary of the report on the website to invite responses from other concerned persons having a plausible stake in the environmental aspects of the project or activity.
- If SPCB/UTPCC is unable to conduct the public hearing in the prescribed time, the Central Government incase of Category A projects and State Government or UT administration in case of Category B projects at the request of the SEIAA can engage any other agency or authority for conducting the public hearing process within a further period of 45 days. The respective governments shall pay the appropriate fee to the public agency for conducting public hearing.
- A public agency means a non-profit making institution/body such as technical/ academic institutions, government bodies not subordinate to the concerned Authority.
- If SPCB/Public Agency authorized for conducting public hearing informs the Authority, stating that it is not possible to conduct the public hearing in a manner, which will enable the views of the concerned local persons to be freely expressed, then Authority may consider such report to take a decision that in such particular case, public consultation may not have the component of public hearing.
- Often restricting the public hearing to the specific district may not serve the entire purpose, therefore, NGOs who are local and registered under the Societies Act in the adjacent districts may also be allowed to participate in public hearing, if they so desire.
- Confidential information including non-disclosable or legally privileged information involving intellectual property right, source specified in the application shall not be placed on the website.
- The Authority shall make available on a written request from any concerned person the draft EIA report for inspection at a notified place during normal office hours till the date of the public hearing.
- While mandatory requirements will have to be adhered to, utmost attention shall be given to the issues raised in the public hearing for determining the modifications needed in the project proposal and the EMP to address such issues.
- Final EIA report after making needed amendments, as aforesaid, shall be submitted by the proponent to the concerned Authority for prior environmental clearance. Alternatively, a supplementary report to draft EIA and EMP addressing all concerns expressed during the public consultation may be submitted.

4.11 Appraisal

Appraisal means the detailed scrutiny by the EAC/SEAC of the application and the other documents like the final EIA report, outcome of the public consultation including public hearing proceedings submitted by the proponent for grant of prior environmental clearance.

- The appraisal shall be made by EAC to the Central Government or SEAC to SEIAA.
- Project proponent either personally or through consultant can make a presentation to EAC/SEAC for the purpose of appraising the features of the project proposal and also to clarify the issues raised by the members of the EAC/SEAC.
- On completion of these proceedings, concerned EAC/SEAC shall make categorical recommendations to the respective Authority, either for grant of prior environmental clearance on stipulated terms & conditions, if any, or rejection of the application with reasons.
- In case EAC/SEAC needs to visit the site or obtain further information before being able to make categorical recommendations, EAC/SEAC may inform the project proponent accordingly. In such an event, it should be ensured that the process of prior environmental clearance is not unduly delayed to go beyond the prescribed timeframe.
- Upon the scrutiny of the final report, if EAC/SEAC opines that ToR for EIA studies finalized at the scoping stage are covered by the proponent, then the project proponent may be asked to provide such information. If such information is declined by the project proponent or is unlikely to be provided early enough so as to complete the environmental appraisal within prescribed time of 60 days, the EAC/SEAC may recommend for rejection of the proposal with the same reason.
- Appraisal shall be strictly in terms of ToR for EIA studies finalized at the scoping stage and the concerns expressed during public consultation.
- This process of appraisal shall be completed within 60 days from the receipt of the updated EIA and EMP reports, after completing public consultation.
- The EIA report will be typically examined for following:
  - Project site description supported by topographic maps & photographs – detailed description of topography, land use and activities at the proposed project site and its surroundings (buffer zone) supported by photographic evidence.
  - Clarity in description of drainage pattern, location of eco-sensitive areas, vegetation characteristics, wildlife status - highlighting significant environmental attributes such as feeding, breeding and nesting grounds of wildlife species, migratory corridor, wetland, erosion and neighboring issues.
  - Description of the project site – how well the interfaces between the project related activities and the environment have been identified for the entire project cycle *i.e.* construction, operation and decommissioning at the end of the project life.
  - How complete and authentic are the baseline data pertaining to flora and fauna and socio-economic aspects?
  - Citing of proper references, with regard to the source(s) of baseline data as well as the name of the investigators/investigating agency responsible for collecting the primary data.

- How consistent are the various values of environmental parameters with respect to each other?
- Is a reasonable assessment of the environmental and social impact made for the identified environmental issues including project affected people?
- To what extent the proposed environmental plan will mitigate the environmental impact and at what estimated cost, shown separately for construction, operation and closure stages and also separately in terms of capital and recurring expenses along with details of agencies that will be responsible for the implementation of environmental plan/ conservation plan.
- How well the concerns expressed/highlighted during public hearing have been addressed and incorporated in the EMP giving item wise financial provisions and commitments (in quantified terms)?
- How far the proposed environmental monitoring plan will effectively evaluate the performance of EMP? Are details for environmental monitoring plan provided in the same manner as the EMP?
- Identification of hazard and quantification of risk assessment and whether appropriate mitigation plan has been included in the EMP?
- Does the proposal include a well formulated time bound green belt development plan for mitigating environmental problems such as fugitive emission of dust, gaseous pollutants, noise, odour, *etc*?
- Does EIA make a serious attempt to guide the project proponent for minimizing the requirement of natural resources including land, water energy and other non renewable resources?
- How well has the EIA statement been organized and presented so that the issues, their impact and environmental management strategies emerge clearly from it and how well organized was the power point presentation made before the expert committee?
- Is the information presented in the EIA adequately and appropriately supported by maps, imageries and photographs highlighting site features and environmental attributes?

4.12 Decision Making

The Chairperson reads the sense of the Committee and finalizes the draft minutes of the meeting, which are circulated by the Secretary to all expert members invited to the meeting. Based on the response from the members, the minutes are finalized and signed by the Chairperson. This process for finalization of the minutes should be so organized that the time prescribed for various stages is not exceeded.

Approval / Rejection / Reconsideration

- The Authority shall consider the recommendations of concerned appraisal Committee and convey its decision within 45 days of the receipt of recommendations.
- If the Authority disagrees with the recommendations of the Appraisal Committee, then reasons shall be communicated to concerned Appraisal Committee and proponent within 45 days from the receipt of the recommendations. The Appraisal Committee concerned shall consider the observations of the Authority and furnish its views on the

observations within further period of 60 days. The Authority shall take a decision within the next 30 days based on the views of appraisal Committee.

- If the decision of the Authority is not conveyed within the time, then the proponent may proceed as if the prior environmental clearance sought has been granted or denied by the regulatory authority in terms of the final recommendation of the concerned appraisal Committee. For this purpose, the decision of the Appraisal Committee will be a public document, once the period specified above for taking the decision by the Authority is over.
- In case of the Category B projects, application shall be received by the Member Secretary of the SEIAA and clearance shall also be issued by the same SEIAA.
- Deliberate concealment and/or submission of false or misleading information or data which is material to screening or scoping or appraisal or decision on the application shall make the application liable for rejection, and cancellation of prior environmental clearance granted on that basis. Rejection of an application or cancellation of a prior environmental clearance already granted, on such ground, shall be decided by the regulatory authority, after giving a personal hearing to the applicant, and following the principles of natural justice.

If approved

- The Concerned MoEF/SEIAA will issue a prior environmental clearance for the project.
- The project proponent should make sure that the award of prior environmental clearance is properly publicized in at least two local newspapers of the district or state where the proposed project is located. For instance, the executive summary of the prior environmental clearance may be published in the newspaper along with the information about the location (website/office where it is displayed for public) where the detailed prior environmental clearance is made available. The MoEF and SEIAA/UTEIAA, as the case may be, shall also place the prior environmental clearance in the public domain on Government Portal. Further copies of the prior environmental clearance shall be endorsed to the Heads of local bodies, Panchayats and Municipal bodies in addition to the relevant offices of the Government.
- The prior environmental clearance will be valid from the start date to actual commencement of the production of the developmental activity.
- Usual validity period will be 5 years from the date of issuing environmental clearance, unless specified by EAC/SEAC.
- A prior environmental clearance issued to a project proponent can be transferred to another legal person entitled to undertake the project, upon application by the transferor to the concerned Authority or submission of no-objection of the transferor by the transferee to the concerned Authority for the concurrence. In this case, EAC/SEAC concurrence is not required, but approval from the concerned authority is required to avail the same project configurations, validity period transferred to the new legally entitled person to undertake the project.

4.13 Post-clearance Monitoring Protocol

The MoEF, Government of India will monitor and take appropriate action under the EP Act, 1986.

- In respect of Category A projects, it shall be mandatory for the project proponent to make public the environmental clearance granted for their project along with the environmental conditions and safeguards at their cost by advertising it at least in two local newspapers of the district or State where the project is located and in addition, this shall also be displayed in the project proponents website permanently.
- In respect of Category B projects, irrespective of its clearance by MoEF/SEIAA, the project proponent shall prominently advertise in the newspapers indicating that the project has been accorded environment clearance and the details of MoEF website where it is displayed.
- The MoEF and the SEIAA/UTEIAA, as the case may be, shall also place the environmental clearance in the public domain on Government Portal.
- Copies of environmental clearance shall be submitted by the project proponents to the Heads of the local bodies, Panchayats and Municipal bodies in addition to the relevant offices of the Government who in turn have to display the same for 30 days from the date of receipt.

The project proponent must submit half-yearly compliance reports in respect of the stipulated prior environmental clearance terms and conditions in hard and soft copies to the regulatory authority concerned, on 1st June and 1st December of each calendar year.

All such compliance reports submitted by the project management shall be public documents. Copies of the same shall be given to any person on application to the concerned regulatory authority. Such compliance report shall also be displayed on the web site of the concerned regulatory Authority.

The SPCB shall incorporate EIA clearance conditions into consent conditions in respect of Category A and Category B projects and in parallel shall monitor and enforce the same.

5. STAKEHOLDERS' ROLES AND RESPONSIBILITIES

Prior environmental clearance process involves many stakeholders *i.e.*, Central Government, State Government, SEIAA, EAC at the National Level, SEAC, Public Agency, SPCB, the project proponent, and the public.

- Roles and responsibilities of the organizations involved in different stages of prior environmental clearance are listed in Table 5-1.
- Organization-specific functions are listed in Table 5-2.

In this Chapter, constitution, composition, functions, *etc*., of the Authorities and the Committees are discussed in detail.

Table 5-1: Roles and Responsibilities of Stakeholders Involved in Prior Environmental Clearance

Stage	MoEF/ SEIAA	EAC/ SEAC	Project Proponent	EIA Consultant	SPCB/ Public Agency	Public and Interest Group
Screening	Receives application and takes advice of EAC/ SEAC	Advises the MoEF/ SEIAA	Submits application (Form 1) and provides necessary information	Advises and assists the proponent by providing technical information		
Scoping	Approves the ToR, communicates the same to the project proponent and places the same in the website	Reviews the ToR, visits the proposed site, if required and recommends the ToR to the MoEF/ SEIAA	Submits the draft ToR to SEIAA and facilitates the visit of the EAC/SEAC members to the project site	Prepares ToR		
EIA Report & Public Hearing	Reviews and forwards copies of the EIA report to SPCB /public agency for conducting public hearing Places the summary		Submits detailed EIA report as per the finalized ToR Facilitates the public hearing by arranging presentation on the project, EIA and EMP – takes note of objections and updates the EMP	Prepares the EIA report Presents and appraises the likely impacts and pollution control measures proposed in the public hearing	Reviews EIA report and conducts public hearing in the manner prescribed Submits proceedings and views of SPCB, to the	Participates in public hearings and offers comments and observations. Comments can be sent directly to SEIAA through Internet in

	of EIA report in the website Conveys objections to the project proponent for update, if any		accordingly		Authority and the project proponent as well	response to the summary placed in the website
Appraisal and Clearance	Receives updated EIA Takes advice of EAC/ SEAC, approves EIA and attaches the terms and conditions	Critically examines the reports, presentation of the proponent and appraises MoEF/ SEIAA (recommendations are forwarded to MoEF/ SEIAA)	Submits updated EIA, EMP reports to MoEF/SEIAA. Presents the overall EIA and EMP including public concerns to EAC/SEAC	Provides technical advise to the project proponent and if necessary presents the proposed measures for mitigation of likely impacts (terms and conditions of clearance)		
Post-clearance Monitoring			Implements environmental protection measures prescribed and submits periodic monitoring results	Conducts periodic monitoring	Incorporates the clearance conditions into appropriate consent conditions and ensures implementation	

Table 5-2: Organization-specific Functions

Organization	Functions
Central Government	▪ Constitutes the EAC ▪ Considering recommendations of the State Government, constitutes the SEIAA & SEAC ▪ Receives application from the project proponent in case of Category A projects or Category B projects attracting general condition ▪ Communicates the ToR finalized by the EAC to the project proponent. ▪ Receives EIA report from the project proponent and soft copy of summary of the report for placing in the website ▪ Summary of EIA report will be placed in website. Forwards the received responses to the project proponent ▪ Engages other public agency for conducting public hearings in cases where the SPCB does not respond within time ▪ Receives updated EIA report from project proponent incorporating the considerations from the proceedings of public hearing and responses received

Organization	Functions
	through other media ▪ Forwards updated EIA report to the EAC for appraisal ▪ Either accepts the recommendations of EAC or asks for reconsideration of specific issues for review by the EAC. ▪ Takes the final decision – acceptance/ rejection – of the project proposal and communicates the same to the project proponent
State Government	▪ Identifies experts as per the composition specified in the Notification and subsequent guidelines to recommend to the the Central Government. ▪ Extends funding support to fulfill the functions of SEIAA/SEAC ▪ Engages other public agency for conducting public hearings in cases where the SPCB does not respond within time ▪ State Governments will suitably pay the public agency for conducting such activity
EAC	▪ Reviews Form 1 and its attachments ▪ Visits site(s), if necessary ▪ Finalizes ToR and recommends to the Central Government, which in turn communicates the finalized ToR to the project proponent, if not exempted by the Notification ▪ Reviews EIA report, proceedings and appraises their views to the Central government ▪ If the Central Government has any specific views, then the EAC reviews again for appraisal
SEIAA	▪ Receives application from the project proponent ▪ Considers SEAC's views for finalization of ToR ▪ Communicates the finalized ToR to the project proponent ▪ Receives EIA report from project proponent ▪ Uploads the summary of EIA report in the website in cases of Category B projects ▪ Forwards the responses received to the project proponent ▪ Receives updated EIA report from project proponent incorporating the considerations from the proceedings of public hearing and responses received through other media ▪ Forwards updated EIA report to SEAC for appraisal ▪ Either accepts the recommendations of SEAC or asks for reconsideration of specific issues for review by SEAC. ▪ Takes the final decision and communicates the same to the project proponent
SEAC	▪ Reviews Form 1 ▪ If necessary visits, site(s) for finalizing the ToR ▪ Reviews updated EIA - EMP report and ▪ Appraises the SEIAA
SPCB	▪ Receives request from project proponent and conducts public hearing in the manner prescribed. ▪ Conveys proceedings to concerned authority and project proponent
Public Agency	▪ Receives request from the respective Governments to conduct public hearing ▪ Conducts public hearing in the manner prescribed. ▪ Conveys proceedings to the concerned Authority/EAC /Project proponent

5.1 SEIAA

- SEIAA is constituted by the MoEF to take final decision regarding the acceptance/rejection of prior environmental clearance to the project proposal for all Category 'B' projects.

- The state government may decide whether to house them at the Department of Environment or at any other Board for effective operational support.
- State Governments can decide whether the positions are permanent or part-time. The Central Government (MoEF) continues to follow the model of paying fee (TA/DA, accommodation, and sitting fee) to the Chairperson and the members of EAC. As such, the State Government is to fund SEIAA & SEAC and decide the appropriate institutional support for them.

A. Constitution

- SEIAA is constituted by the Central Government comprising of three members including a Chairperson and Member–Secretary to be nominated by the State Government or UT Administration concerned.
- The Central Government will notify as and when the nominations (in order) are received from the State Governments, within 30 days from the date of receipt.
- The Chairperson and the non-official member shall have a fixed term of three years, from the date of Notification by the Central Government constituting the Authority.

The form used by the State Governments to submit nominations for Notification by the Central Government is provided in **Annexure XIV**.

B. Composition

- Chairperson shall be an expert in the EIA process
- Member–Secretary shall be a serving officer of the concerned State Government/ UT Administration familiar with the environmental laws.
- Member–Secretary may be of a level equivalent to the Director, Dept. of Environment or above – a full time member.
- All the members including the Chairperson shall be the experts as per the criteria set in the Notification.
- The Government servants can only serve as the Member–Secretary to SEIAA and the Secretary to SEAC. All other members including Chairperson of the SEIAA and SEAC shall not be comprised of serving Government Officers; sector representatives; and the activists.
- Serving faculty (academicians) is eligible for the membership in the Authority and/or the Committees, if they fulfill the criteria given in Appendix VI to the Notification.
- This is to clarify that the serving Government officers shall not be nominated as professional/expert member of SEIAA/SEAC/EAC.
- Professionals/Experts in the SEIAA and SEAC shall be different.

Summary regarding the eligibility criteria for Chairperson and Members of the SEIAA is given in Table 5-3.

C. Decision-making process

- The decision of the Authority shall be arrived through consensus.
- If there is no consensus, the Authority may either ask SEAC for reconsideration or may reject the approval.

- All decisions of the SEIAA shall be taken in a meeting and shall ordinarily be unanimous. In case a decision is taken by majority, the details of views, for and against the decision, shall be clearly recorded in minutes of meeting and a copy thereof shall be sent to MoEF.

Table 5-3: SEIAA: Eligibility Criteria for Chairperson/ Members/ Secretary

S. No.	Attribute		Requirement		
			Members	Member–Secretary	Chairperson
1	Professional qualification as per the Notification		Compulsory	Compulsory	Compulsory
2	Experience (Fulfilling any one of a, b, c)	a	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI
		b	Professional Qualification +PhD+10 years of experience in one of the expertise area mentioned in Appendix VI	Professional Qualification +PhD+10 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification +PhD+10 years of experience in one of the expertise area mentioned in the Appendix VI
		c	Professional Qualification +10 years of experience in one of the expertise area mentioned in the Appendix VI + 5 years interface with environmental issues, problems and their management	Professional Qualification +10 years of experience in one of the expertise area mentioned in the Appendix VI + 5 years interface with environmental issues, problems and their management	----------
3	Test of independence (conflict of interest) and minimum grade of the Secretary of the Authority		Shall not be a serving government officer Shall not be a person engaged in industry and their associations Shall not be a person associated with environmental activism	Only serving officer from the State Government (DoE) familiar with environmental laws not below the level of Director	Shall not be a serving government officer Shall not be a person engaged in industry and their associations Shall not be a person associated with environmental activism
4	Age		Below 67 years at the time of Notification of the Authority	As per State Government Service Rules	Below 72 Years at the time of the Notification of the Authority
5	Other memberships in Central/State Expert Appraisal Committee		Shall not be a member in any SEIAA/EAC/SEAC	Shall not be a member in any SEIAA/EAC/SEAC	Shall not be a member in any SEIAA/EAC/SEAC
6	Tenure of earlier appointment (continuous)		Only one term before this in continuity is	Not applicable	Only one term before this in

S. No.	Attribute	Requirement		
		Members	Member–Secretary	Chairperson
		permitted		continuity is permitted
7	Eminent environmental expertise with understanding on environmental aspects and impacts	Desirable	Desirable	Compulsory
8	Expertise in the environmental clearance process	Desirable	Desirable	Compulsory

Note:

1. A member after continuous membership in two terms (6 years) shall not be considered for further continuation. His/her nomination may be considered after a gap of one term (three years), if other criteria meet.

2. Chairperson/Member once notified may not be removed prior to the tenure of three years without cause and proper enquiry.

5.2 EAC and SEAC

EAC and SEAC are independent Committees to review each developmental activity and offer its recommendations for consideration of the Central Government and SEIAA respectively.

A. Constitution

- EAC and SEAC shall be constituted by the Central Government comprising a maximum of 15 members including a Chairperson and Secretary. In case of SEAC, the State Government or UT Administration is required to nominate the professionals/experts for consideration and Notification by the Central Government.
- The Central Government will notify as and when the nominations (in order) are received from the State Governments, within 30 days from the date of receipt.
- The Chairperson and the non-official member shall have a fixed term of three years, from the date of Notification by the Central Government.
- The Chairperson shall be an eminent environmental expert with understanding on environmental aspects and environmental impacts. The Secretary of the SEAC shall be a State Government officer, not below the level of a Director/Chief Engineer.
- The members of the SEAC need not be from the same State/UT.
- In case the State Governments/ Union Territories so desire, the MoEF can form regional EAC to serve the concerned States/Union Territories.
- State Governments may decide to their convenience to house SEAC at the Department of Environment or at SPCB or at any other department, to extend support to the SEAC activities.

B. Composition

- Composition of EAC/SEAC as per the Notification is given in **Annexure XV.**
- Secretary to EAC/SEAC may invite a maximum of two professionals/experts with the prior approval of the Chairperson, if desired, for taking the advisory inputs for appraisal. In such case, the invited experts will not take part in the decision making process
- The Secretary of each EAC/SEAC preferably is an officer of the level equivalent to or above the level of Director, MoEF, GoI.

C. Decision making

The EAC and SEAC shall function on the principle of collective responsibility. The Chairperson shall endeavour to reach a consensus in each case, and if consensus cannot be reached, the view of the majority shall prevail.

D. Operational issues

- Secretary may deal with all correspondence, formulate agenda and prepare agenda notes. Chairperson and other members may act only for the meetings.
- Chairperson of EAC/SEAC shall be one among the expert members having considerable professional experience with proven credentials.
- EAC/SEAC shall meet at least once every month or more frequently, if so needed, to review project proposals and to offer recommendations for the consideration of the Authority.
- EAC/SEAC members may inspect the site at various stages *i.e*. during screening, scoping and appraisal, as per the need felt and decided by the Chairperson of the Committee.
- The respective Governments through the Secretary of the Committee may pay/reimburse the participation expenses, honorarium *etc*., to the Chairperson and members.

i. Tenure of EAC/SEIAA/SEAC

The tenure of Authority/Committee(s) shall be for a fixed period of three years. At the end of the three years period, the Authority and the committees need to be re-constituted. However, staggered appointment dates may be adopted to maintain continuity of members at a given point of time.

ii. Qualifying criteria for nomination of a member to EAC/SEIAA/SEAC

While recommending nominations and while notifying the members of the Authority and Expert Committees, it shall be ensured that all the members meet the following three criteria:

- Professional qualification
- Relevant experience/Experience interfacing with environmental management
- Absence of conflict of interest

These are elaborated subsequently.

a) Professional qualification

The person should have at least (i) 5 years of formal University training in the concerned discipline leading to a MA/MSc Degree, or (ii) in case of Engineering/Technology/ Architecture disciplines, 4 years formal training in a professional training course together with prescribed practical training in the field leading to a B.Tech/B.E./B.Arch. Degree, or (iii) Other professional degree (e.g. Law) involving a total of 5 years of formal University training and prescribed practical training, or (iv) Prescribed apprenticeship/articleship and pass examinations conducted by the concerned professional association (e.g. MBA/IAS/ IFS). In selecting the individual professionals, experience gained by them in their respective fields will be taken note of.

b) Relevant experience

- Experience shall be related to professional qualification acquired by the person and be related to one or more of the expertise mentioned for the expert members. Such experience should be a minimum of 15 years.
- When the experience mentioned in the foregoing sub-paragraph interfaces with environmental issues, problems and their management, the requirement for the length of the experience can be reduced to a minimum of 10 years.

c) Absence of conflict of interest

For the deliberations of the EAC/SEAC to be independent and unbiased, all possibilities of potential conflict of interests have to be eliminated. Therefore, serving government officers; persons engaged in industry and their associations; persons associated with the formulation of development projects requiring prior environmental clearance, and persons associated with environmental activism shall not be considered for membership of SEIAA/ SEAC/ EAC.

iii. Age

Below 70 years for the members and below 72 years for the Chairperson of the SEIAA/SEAC/EAC. The applicability of the age is at the time of the Notification of the SEIAA/SEAC/EAC by the Central Government.

Summary regarding the eligibility criteria for Chairperson and Members of the EAC/SEAC is given in Table 5-4.

Table 5-4: EAC/SEAC: Eligibility Criteria for Chairperson / Members / Secretary

S. No.	Attribute		Requirement		
			Expert members	Secretary	Chairperson
1	Professional qualification as per the Notification		Compulsory	Compulsory	Compulsory
2	Experience (Fulfilling any one of a, b, c)	a	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI
		b	Professional	Professional	Professional

S. No.	Attribute		Requirement		
			Expert members	Secretary	Chairperson
			Qualification +PhD+10 years of experience in one of the expertise area mentioned in the Appendix VI	Qualification +PhD+10 years of experience in one of the expertise area mentioned in the Appendix VI	Qualification +PhD+10 years of experience in one of the expertise area mentioned in Appendix VI
		c	Professional Qualification +10 years of experience in one of the expertise area mentioned in the Appendix VI + 5 years interface with environmental issues, problems and their management	Professional Qualification +10 years of experience in one of the expertise area mentioned in the Appendix VI + 5 years interface with environmental issues, problems and their management	----------
3	Test of independence (conflict of interest) and minimum grade of the Secretary of the Committees		Shall not be a serving government officer Shall not be a person engaged in industry and their associations Shall not be a person associated with environmental activism	In case of EAC, not less than a Director from the MoEF, Government of India Incase of SEAC, not below the level of Director/Chief Engineer from the State Government (DoE)	Shall not be a serving government officer Shall not be a person engaged in industry and their associations Shall not be a person associated with environmental activism
4	Age		Below 67 years at the time of Notification of the Committee	As per state Government Service Rules	Below 72 Years at the time of the Notification of the Committee
5	Membership in Central/State Expert Appraisal Committee		Only one other than this nomination is permitted	Shall not be a member in other SEIAA/EAC/SEAC	Shall not be a member in any other SEIAA/EAC/SEAC
6	Tenure of earlier appointment (continuous)		Only one term before this in continuity is permitted	Not applicable	Only one term before this in continuity is permitted
7	Eminent environmental expertise with understanding on environmental aspects and impacts		Desirable	Not applicable	Compulsory

Note:

1. A member after continuous membership in two terms (six years) shall not be considered for further continuation. His/her nomination may be reconsidered after a gap of one term (three years), if other criteria meet.

2. Chairperson/Member once notified may not be removed prior to the tenure of 3 years with out cause and proper enquiry. A member after continuous membership in two terms (6 years) shall not

be considered for further continuation. The same profile may be considered for nomination after a gap of three years, i.e., one term, if other criteria are meeting.

E. Other conditions that may be considered

- An expert Committee member of one State/UT, can have at the most another State/UT Committee membership, but in no case more than two Committees at a given point of time.
- An expert member of a Committee shall not have membership continuously in the same committee for more than two terms, *i.e*., six years. They can be nominated after a gap of three years, *i.e*., one term. When a member of Committee has been associated with any development project, which comes for prior environmental clearance, he/she may not participate in the deliberations and the decisions in respect to that particular project.
- At least four members shall be present in each meeting to fulfill the quorum
- If a member does not consecutively attend six meetings, without prior intimation to the Committee his/her membership may be terminated by the Notifying Authority. Prior information for absence due to academic pursuits, career development and national/state-endorsed programmes may be considered as genuine grounds for retention of membership.

ANNEXURE I
Definitions – MSW (Management and Handling) Rules 2000

Definitions: MSW (Management and Handling) rules 2000

i. "**Anaerobic digestion"** means a controlled process involving microbial decomposition of organic matter in the absence of oxygen;

ii. **"Authorization"** means the consent given by the Board or Committee to the "operator of a facility";

iii. "**Biodegradable substance"** means a substance that can be degraded by microorganisms;

iv. **"Biomethanation"** means a process which entails enzymatic decomposition of the organic matter by microbial action to produce methane rich biogas;

v. "**Collection"** means lifting and removal of solid wastes from collection points or any other location;

vi. "**Composting"** means a controlled process involving microbial decomposition of organic matter;

vii. "**Demolition and construction waste"** means wastes from building materials debris and rubble resulting from construction, re-modeling, repair and demolition operation;

viii. "**Disposal"** means final disposal of municipal solid wastes in terms of the specified measures to prevent contamination of ground-water, surface water and ambient air quality;

ix. **"Form"** means a Form appended to these rules;

x. **"Generator of wastes"** means persons or establishments generating municipal solid wastes;

xi. "**Land filling"** means disposal of residual solid wastes on land in a facility designed with protective measures against pollution of ground water, surface water and air fugitive dust, wind-blown litter, bad odour, fire hazard, bird menace, pests or rodents, greenhouse gas emissions, slope instability and erosion;

xii. "**Leachate"** means liquid that seeps through solid wastes or other medium and has extracts of dissolved or suspended material from it;

xiii. "**Lysimeter"** is a device used to measure rate of movement of water through or from a soil layer or is used to collect percolated water for quality analysis;

xiv. **"Municipal authority"** means Municipal Corporation, Municipality, Nagar Palika, Nagar Nigam, Nagar Panchayat, Municipal Council including notified area committee (NAC) or any other local body constituted under the relevant statutes and, where the management and handling of municipal solid waste is entrusted to such agency;

xv. **"Municipal solid waste"** includes commercial and residential wastes generated in a municipal or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes;

xvi. **"Operator of a facility"** means a person who owns or operates a facility for collection, segregation, storage, transportation, processing and disposal of municipal solid wastes and also includes any other agency appointed as such by the municipal authority for the management and handling of municipal solid wastes in the respective areas;

xvii. **"Pelletisation"** means a process whereby pellets are prepared which are small cubes or cylindrical pieces made out of solid wastes and includes fuel pellets which are also referred as refuse derived fuel;

xviii. "**Processing"** means the process by which solid wastes are transformed into new or recycled products;

xix. "**Recycling"** means the process of transforming segregated solid wastes into raw materials for producing new products, which may or may not be similar to the original products;

xx. **"Schedule"** means a Schedule appended to these rules;

xxi. **"Segregation"** means to separate the municipal solid wastes into the groups of organic, inorganic, recyclables and hazardous wastes;

xxii. **"State Board or the Committee"** means the State Pollution Control Board of a State, or as the case may be, the Pollution Control Committee of a Union territory;

xxiii. **"Storage"** means the temporary containment of municipal solid wastes in a manner so as to prevent littering, attraction to vectors, stray animals and excessive foul odour;

xxiv. **"Transportation "** means conveyance of municipal solid wastes from place to place hygienically through specially designed transport system so as to prevent foul odour, littering, unsightly conditions and accessibility to vectors;

xxv. "**Vadose water"** water which occurs between the ground, surface and the water table that is the unsaturated zone;

xxvi. "**Vermicomposting"** is a process of using earthworms for conversion of biodegradable wastes into compost.

ANNEXURE II
Waste Generation and Composition

Waste Generation and Composition

- Total quantity of waste generated in the country (based on weighment exercise by local bodies) is not reported. However, Ministry of Urban Development in its manual on solid waste management (year 2000) has estimated waste generation of 100,000 MT.

- CPCB with the assistance of NEERI has conducted survey of solid waste management in 59 cities (35 metro cities and 24 state Capitals: 2004-05)

- Quantities and waste generation rate in 59 cities is as under.

S. No	Name of City	Population (As per 2001 census)	Area (Sq. Km)	Waste Quantity (TPD)	Waste Generation Rate (kg/c/day)
1	Kavaratti	10,119	4	3	0.30
2	Gangtok	29,354	15	13	0.44
3	Itanagar	35,022	22	12	0.34
4	Daman	35,770	7	15	0.42
5	Silvassa	50,463	17	16	0.32
6	Panjim	59,066	69	32	0.54
7	Kohima	77,030	30	13	0.17
8	Port Blair	99,984	18	76	0.76
9	Shillong	1,32,867	10	45	0.34
10	Simla	1,42,555	20	39	0.27
11	Agartala	1,89,998	63	77	0.40
12	Gandhinagar	1,95,985	57	44	0.22
13	Dhanbad	1,99,258	24	77	0.39
14	Pondicherry	2,20,865	19	130	0.59
15	Imphal	2,21,492	34	43	0.19
16	Aizwal	2,28,280	117	57	0.25
17	Jammu	3,69,959	102	215	0.58
18	Dehradun	4,26,674	67	131	0.31
19	Asansol	4,75,439	127	207	0.44
20	Kochi	5,95,575	98	400	0.67
21	Raipur	6,05,747	56	184	0.30
22	Bhubaneswar	6,48,032	135	234	0.36
23	Tiruvanantapuram	7,44,983	142	171	0.23
24	Chandigarh	8,08,515	114	326	0.40
25	Guwahati	8,09,895	218	166	0.20
26	Ranchi	8,47,093	224	208	0.25
27	Vijaywada	8,51,282	58	374	0.44
28	Srinagar	8,98,440	341	428	0.48
29	Madurai	9,28,868	52	275	0.30
30	Coimbatore	9,30,882	107	530	0.57
31	Jabalpur	9,32,484	134	216	0.23

32	Amritsar	9,66,862	77	438	0.45
33	Rajkot	9,67,476	105	207	0.21
34	Allahabad	9,75,393	71	509	0.52
35	Vishakhapatnam	9.82,904	110	584	0.59
36	Faridabad	10,55,938	216	448	0.42
37	Meerut	10,68,772	142	490	0.46
38	Nashik	10,77,236	269	200	0.19
39	Varanasi	10,91,918	80	425	0.39
40	Jamshedpur	11,04,713	64	338	0.31
41	Agra	12,75,135	140	654	0.51
42	Vadodara	13,06,227	240	357	0.27
43	Patna	13,66,444	107	511	0.37
44	Ludhiana	13,98,467	159	735	0.53
45	Bhopal	14,37,354	286	574	0.40
46	Indore	14,74,968	130	557	0.38
47	Nagpur	20,52,066	218	504	0.25
48	Lucknow	21,85,927	310	475	0.22
49	Jaipur	23,22,575	518	904	0.39
50	Surat	24,33,835	112	1000	0.41
51	Pune	25,38,473	244	1175	0.46
52	Kanpur	25,51,337	267	1100	0.43
53	Ahmedabad	35,20,085	191	1302	0.37
54	Hyderabad	38,43,585	169	2187	0.57
55	Banglore	43,01,326	226	1669	0.39
56	Chennai	43,43,645	174	3036	0.62
57	Kolkata	45,72,876	187	2653	0.58
58	Delhi	1,03,06,452	1483	5922	0.57
59	Greater Mumbai	1,19,78,450	437	5320	0.45

- Characterisation of waste is necessary to know changing trends in composition of waste. Based on composition/ characterization of waste, appropriate selection of waste processing technologies could be selected.

- Waste characterisation in 59 cities is indicated below:

S. No	Name of City	Compostables (%)	Recyclables (%)	C/N Ratio	HCV* (Kcal/Kg)	Moisture (%)
1	Kavarati	46.01	27.20	18.04	2242	25
2	Gangtok	46.52	16.48	25.61	1234	44
3	Itanagar	52.02	20.57	17.68	3414	50
4	Daman	29.60	22.02	22.34	2588	53
5	Silvassa	71.67	13.97	35.24	1281	42
6	Panjim	61.75	17.44	23.77	2211	47
7	Kohima	57.48	22.67	30.87	2844	65
8	Port Blair	48.25	27.66	35.88	1474	63
9	Shillong	62.54	17.27	28.86	2736	63
10	Simla	43.02	36.64	23.76	2572	60

11	Agartala	58.57	13.68	30.02	2427	60
12	Gandhinagar	34.30	13.20	36.05	698	24
13	Dhanbad	46.93	16.16	18.22	591	50
14	Pondicherry	49.96	24.29	36.86	1846	54
15	Imphal	60.00	18.51	22.34	3766	40
16	Aizwal	54.24	20.97	27.45	3766	43
17	Jammu	51.51	21.08	26.79	1782	40
18	Dehradun	51.37	19.58	25.90	2445	60
19	Asansol	50.33	14.21	14.08	1156	54
20	Kochi	57.34	19.36	18.22	591	50
21	Raipur	51.40	16.31	223.50	1273	29
22	Bhubaneswar	49.81	12.69	20.57	742	59
23	Tiruvananthapuram	72.96	14.36	35.19	2378	60
24	Chandigarh	57.18	10.91	20.52	1408	64
25	Guwahati	53.69	23.28	17.71	1519	61
26	Ranchi	51.49	9.86	20.23	1060	49
27	Vijaywada	59.43	17.40	33.90	1910	46
28	Srinagar	6177	17.76	22.46	1264	61
29	Madurai	55.32	17.25	32.69	1813	46
30	Coimbatore	50.06	15.52	45.83	2381	54
31	Jabalpur	58.07	16.61	28.22	2051	35
32	Amritsar	65.02	13.94	30.69	1836	61
33	Rajkot	41.50	11.20	52.56	687	17
34	Allahabad	35.49	19.22	19.00	1180	18
35	Visakhapatnam	45.96	24.20	41.70	1602	53
36	Faridabad	42.06	23.31	18.58	1319	34
37	Meerut	54.54	10.96	19.24	1089	32
38	Nasik	39.52	25.11	37.20	2762	62
39	Varanasi	45.18	17.23	19.40	804	44
40	Jamshedpur	43.36	15.69	19.69	1009	48
41	Agra	46.38	15.79	21.56	520	28
42	Vadodara	47.43	14.50	40.34	1781	25
43	Patna	51.96	12.57	18.62	819	36
44	Ludhiana	49.80	19.32	52.17	2559	65
45	Bhopal	52.44	22.33	21.58	1421	43
46	Indore	48.97	12.57	29.30	1437	31
47	Nagpur	47.41	15.53	26.37	2632	41
48	Lucknow	47.41	15.53	21.41	1557	60
49	Jaipur	45.50	12.10	43.29	834	21
50	Surat	56.87	11.21	42.16	990	51
51	Pune	62.44	16.66	35.54	2531	63
52	Kanpur	47.52	11.93	27.64	1571	46
53	Ahemdabad	40.81	11.65	29.64	1180	32
54	Hyderabad	54.20	21.60	25.90	1969	46
55	Bangalore	51.84	22.43	35.12	2386	55

56	Chennai	41.34	16.34	29.25	2594	47
57	Kolkata	50.56	11.48	31.81	1201	46
58	Delhi	54.42	15.52	34.87	1802	49
59	Greater Mumbai	62.44	16.66	39.04	1786	54

ANNEXURE III
Schedules from MSW 2000 Rules

Schedule I

[See rules4 (2) and (3)]

Implementation Schedule

Serial No.	**Compliance Criteria**	**Schedule**
1.	Setting up of waste processing and disposal facilities	By 31.12.2003 or earlier
2.	Monitoring the performance of waste processing and disposal facilities	Once in six months
3.	Improvement of existing landfill sites as per provisions of these rules	By 31.12.2001 or earlier
4.	Identification of landfill sites for future use and making site (s) ready for operation	By 31.12.2002 or earlier

Schedule -II

[See rules 6(1) and (3), 7(1)]

Management of Municipal Solid Wastes

S. No	Parameters	Compliance criteria
1.	**Collection of municipal solid wastes**	1. Littering of municipal solid waste shall be prohibited in cities, towns and in urban areas notified by the State Governments. To prohibit littering and facilitate compliance, the following steps shall be taken by the municipal authority, namely: - i. Organizing house-to-house collection of municipal solid wastes through any of the methods, like community bin collection (central bin), house-to-house collection, collection on regular pre-informed timings and scheduling by using bell ringing of musical vehicle (without exceeding permissible noise levels); ii. Devising collection of waste from slums and squatter areas or localities including hotels, restaurants, office complexes and commercial areas; iii. Wastes from slaughter houses, meat and fish markets, fruits and vegetable markets, which are biodegradable in nature, shall be managed to make use of such wastes; iv. Bio-medical wastes and industrial wastes shall not be mixed with municipal solid wastes and such wastes shall follow the rules separately specified for the purpose; v. Collected waste from residential and other areas shall be transferred to community bin by hand-driven containerized carts or other small vehicles; vi. Horticultural and construction or demolition wastes or debris shall be separately collected and disposed off following proper norms. Similarly, wastes generated at dairies shall be regulated in accordance with the State laws; vii. Waste (garbage, dry leaves) shall not be burnt; viii. Stray animals shall not be allowed to move around waste storage facilities or at any other place in the city or town and shall be managed in accordance with the State laws. 2. The municipal authority shall notify waste collection schedule and the likely method to be adopted for public benefit in a city or town. 3. It shall be the responsibility of generator of wastes to avoid littering and ensure delivery of wastes in accordance with the collection and segregation system to be notified by the municipal authority as per Para 1(2) of this Schedule.

2.	**Segregation of municipal solid wastes**	In order to encourage the citizens, municipal authority shall organize awareness programmes for segregation of wastes and shall promote recycling or reuse of segregated materials. The municipal authority shall undertake phased programme to ensure community participation in waste segregation. For this purpose, regular meetings at quarterly intervals shall be arranged by the municipal authorities with representatives of local resident welfare associations and non-governmental organizations.
3.	**Storage of municipal solid wastes**	Municipal authorities shall establish and maintain storage facilities in such a manner, as they do not create unhygienic and in sanitary conditions around it. Following criteria shall be taken into account while establishing and maintaining storage facilities, namely: - i. Storage facilities shall be created and established by taking into account quantities of waste generation in a given area and the population densities. A storage facility shall be so placed that it is accessible to users; ii. Storage facilities to be set up by municipal authorities or any other agency shall be so designed that wastes stored are not exposed to open atmosphere and shall be aesthetically acceptable and user-friendly; iii. Storage facilities or 'bins' shall have 'easy to operate' design for handling, transfer and transportation of waste. Bins for storage of bio-degradable wastes shall be painted green, those for storage of recyclable wastes shall be printed white and those for storage of other wastes shall be printed black; iv. Manual handling of waste shall be prohibited. If unavoidable due to constraints, manual handling shall be carried out under proper precaution with due care for safety of workers.
4.	**Transportation of municipal solid wastes**	Vehicles used for transportation of wastes shall be covered. Waste should not be visible to public, nor exposed to open environment preventing their scattering. The following criteria shall be met, namely: - i. The storage facilities set up by municipal authorities shall be daily attended for clearing of wastes. The bins or containers wherever placed shall be cleaned before they start overflowing; ii. Transportation vehicles shall be so designed that multiple handling of wastes, prior to final disposal, is avoided.
5.	**Processing of municipal solid wastes**	Municipal authorities shall adopt suitable technology or combination of such technologies to make use of wastes so as to minimize burden on

		landfill. Following criteria shall be adopted, namely: - (i) The biodegradable wastes shall be processed by composting, vermicomposting, anaerobic digestion or any other appropriate biological processing for stabilization of wastes. It shall be ensured that compost or any other end product shall comply with standards as specified in Schedule-IV; ii. Mixed waste containing recoverable resources shall follow the route of recycling. Incineration with or without energy recovery including pelletisation can also be used for processing wastes in specific cases. Municipal authority or the operator of a facility wishing to use other state-of-the-art technologies shall approach the Central Pollution Control Board to get the standards laid down before applying for grant of authorization.
6.	**Disposal of municipal solid wastes**	Land filling shall be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Land filling shall also be carried out for residues of waste processing facilities as well as pre-processing rejects from waste processing facilities. Land filling of mixed waste shall be avoided unless the same is found unsuitable for waste processing. Under unavoidable circumstances or till installation of alternate facilities, landfilling shall be done following proper norms. Landfill sites shall meet the specifications as given in Schedule –III.

Schedule III

[See rules 6(1) and (3), 7(2)]

Specifications for Landfill Sites

Site Selection

1. In areas falling under the jurisdiction of 'Development Authorities' it shall be the responsibility of such Development Authorities to identify the landfill sites and hand over the sites to the concerned municipal authority for development, operation and maintenance. Elsewhere, this responsibility shall lie with the concerned municipal authority.
2. Selection of landfill sites shall be based on examination of environmental issues. The Department of Urban Development of the State or the Union territory shall co-ordinate with the concerned organizations for obtaining the necessary approvals and clearances.
3. The landfill site shall be planned and designed with proper documentation of a phased construction plan as well as a closure plan.
4. The landfill sites shall be selected to make use of nearby wastes processing facility. Otherwise, wastes processing facility shall be planned as an integral part of the landfill site.
5. The existing landfill sites, which continue to be used for more than five years, shall be improved in accordance of the specifications given in this Schedule.
6. Biomedical wastes shall be disposed off in accordance with the Bio-medical Wastes (Management and Handling) Rules, 1998 and hazardous wastes shall be managed in accordance with the Hazardous Wastes (Management and Handling) Rules, 1989, as amended from time to time.
7. The landfill site shall be large enough to last for 20-25 years.
8. The landfill site shall be away from habitation clusters, forest areas, water bodies monuments, National Parks, Wetlands and places of important cultural, historical or religious interest.
9. A buffer zone of no-development shall be maintained around landfill site and shall be incorporated in the Town Planning Department's land-use plans.
10. Landfill site shall be away from airport including airbase. Necessary approval of airport or airbase authorities prior to the setting up of the landfill site shall be obtained in cases where the site is to be located within 20 km of an airport or airbase.

Facilities at the Site

11. Landfill site shall be fenced or hedged and provided with proper gate to monitor incoming vehicles or other modes of transportation.
12. The landfill site shall be well protected to prevent entry of unauthorized persons and stray animals.
13. Approach and other internal roads for free movement of vehicles and other machinery shall exist at the landfill site.
14. The landfill site shall have wastes inspection facility to monitor wastes brought in for landfill, office facility for record keeping and shelter for keeping equipment and machinery including pollution monitoring equipments.

15. Provisions like weigh bridge to measure quantity of waste brought at landfill site, fire protection equipments and other facilities as may be required shall be provided.
16. Utilities such as drinking water (preferably bathing facilities for workers) and lighting arrangements for easy landfill operations when carried out in night hours shall be provided.
17. Safety provisions including health inspections of workers at landfill site shall be periodically made.

Specifications for land filling

18. Wastes subjected to land filling shall be compacted in thin layers using landfill compactors to achieve high density of the wastes. In high rainfall areas where heavy compactors cannot be used alternative measures shall be adopted.
19. Wastes shall be covered immediately or at the end of each working day with minimum 10 cm of soil, inert debris or construction material till such time waste processing facilities for composting or recycling or energy recovery are set up as per Schedule I.
20. Prior to the commencement of monsoon season, an intermediate cover of 40-65 cm thickness of soil shall be placed on the landfill with proper compaction and grading to prevent infiltration during monsoon. Proper drainage berms shall be constructed to divert run-off away from the active cell of the landfill.
21. After completion of landfill, a final cover shall be designed to minimize infiltration and erosion. The final cover shall meet the following specifications, namely: -

a. The final cover shall have a barrier soil layer comprising of 60 cms of clay or amended soil with permeability coefficient less that 1×10^{-7} cm/sec.
b. On top of the barrier soil layer there shall be a drainage layer of 15 cm.
c. On top of the drainage layer there shall be a vegetative layer of 45 cm to support natural plant growth and to minimize erosion.

Pollution prevention

22. In order to prevent pollution problems from landfill operations, the following provisions shall be made, namely: -

a. Diversion of storm water drains to minimize leachate generation and prevent pollution of surface water and also for avoiding flooding and creation of marshy conditions;
b. Construction of a non-permeable lining system at the base and walls of waste disposal area. For landfill receiving residues of waste processing facilities or mixed waste or waste having contamination of hazardous materials (such as aerosols, bleaches, polishes, batteries, waste oils, paint products and pesticides) minimum liner specifications shall be a composite barrier having 1.5 mm high density polyethylene (HDPE) geomembrane, or equivalent, overlying 90 cm of soil (clay or amended soil) having permeability coefficient not greater than 1×10^{-7} cm/sec. The highest level of water table shall be at least two meter below the base of clay or amended soil barrier layer;
c. Provisions for management of leachate collection and treatment shall be made. The treated leachate shall meet the standards specified in Schedule- IV;
d. Prevention of run-off from landfill area entering any stream, river, lake or pond.

Water Quality Monitoring

23. Before establishing any landfill site, baseline data of ground water quality in the area shall be collected and kept in record for future reference. The ground water quality within 50 meters of the periphery of landfill site shall be periodically monitored to ensure that the ground water is not contaminated beyond acceptable limit as decided by the Ground Water Board or the State Board or the Committee. Such monitoring shall be carried out to cover different seasons in a year that is, summer, monsoon and post-monsoon period.
24. Usage of groundwater in and around landfill sites for any purpose (including drinking and irrigation) is to be considered after ensuring its quality. The following specifications for drinking water quality shall apply for monitoring purpose, namely: -

S.No.	**Parameters**	**IS 10500: 1991 Desirable limit (mg/l except for pH)**
1.	Arsenic	0.05
2.	Cadmium	0.01
3	Chromium	0.05
4.	Copper	0.05
5.	Cyanide	0.05
6.	Lead	0.05
7.	Mercury	0.001
8.	Nickel	-
9.	Nitrate as NO_3	45.0
10	PH	6.5-8.5
11.	Iron	0.3
12.	Total hardness (as $CaCO_3$)	300.0
13.	Chlorides	250
14.	Dissolved solids	500
15.	Phenolic compounds (as C_6H_5OH)	0.001
16.	Zinc	5.0
17.	Sulphate (as SO_4)	200

25. Ambient Air Quality Monitoring
26. Installation of landfill gas control system including gas collection system shall be made at landfill site to minimize odour generation, prevent off-site migration of gases and to protect vegetation planted on the rehabilitated landfill surface.
27. The concentration of methane gas generated at landfill site shall not exceed 25 per cent of the lower explosive limit (LEL).
28. The landfill gas from the collection facility at a landfill site shall be utilized for either direct thermal applications or power generation, as per viability. Otherwise, landfill gas shall be burnt (flared) and shall not be allowed to directly escape to the atmosphere or for illegal tapping. Passive venting shall be allowed if its utilization or flaring is not possible.
29. Ambient air quality at the landfill site and at the vicinity shall be monitored to meet the following specified standards, namely: -

S.No.	**Parameters**	**Acceptable levels**
(i)	Sulphur dioxide	120 µg/m^3 (24 hours)
(ii)	Suspended Particulate Matter	500 µg/m^3 (24 hours)
(iii)	Methane	Not to exceed 25 per cent of the lower explosive limit (equivalent to 650 mg/m^3)
(iv)	Ammonia daily average (Sample duration 24 hrs)	0.4 mg/m^3 (400 µg/m^3)
(v)	Carbon monoxide	1 hour average: 2 mg/m^3 8 hour average: 1 mg/m^3

29. The ambient air quality monitoring shall be carried out by the concerned authority as per the following schedule, namely: -

(a) Six times in a year for cities having population of more than fifty lakhs;

(b) Four times in a year for cities having population between ten and fifty lakhs;

(c) Two times in a year for town or cities having population between one and ten lakhs.

Plantation at Landfill Site

30. A vegetative cover shall be provided over the completed site in accordance with the and following specifications, namely: -

(a) Selection of locally adopted non-edible perennial plants that are resistant to drought and extreme temperatures shall be allowed to grow;

(b) The plants grown be such that their roots do not penetrate more than 30 cms. This condition shall apply till the landfill is stabilized;

(c) Selected plants shall have ability to thrive on low-nutrient soil with minimum nutrient addition;

(d) Plantation to be made in sufficient density to minimize soil erosion.

Closure of Landfill Site and Post-care

31. The post-closure care of landfill site shall be conducted for at least fifteen years and long term monitoring or care plan shall consist of the following, namely: -

(a) Maintaining the integrity and effectiveness of final cover, making repairs and preventing run-on and run-off from eroding or otherwise damaging the final cover;

(b) Monitoring leachate collection system in accordance with the requirement;

(c) Monitoring of ground water in accordance with requirements and maintaining ground water quality;

(d) Maintaining and operating the landfill gas collection system to meet the standards.

32. Use of closed landfill sites after fifteen years of post-closure monitoring can be considered for human settlement or otherwise only after ensuring that gaseous and leachate analysis complies with the specified standards.

Special provisions for hilly areas

33. Cities and towns located on hills shall have location-specific methods evolved for final disposal of solid wastes by the municipal authority with the approval of the concerned State Board or the Committee. The municipal authority shall set up processing facilities for utilization of biodegradable organic wastes. The inert and non-biodegradable waste shall be used for building roads or filling-up of appropriate areas on hills. Because of constraints in finding adequate land in hilly areas, wastes not suitable for road laying or filling up shall be disposed of in specially designed landfills.

Schedule IV

[See rules 6(1) and (3), 7(2)]

Standards for Composting, Treated Leachate and Incineration

1. The waste processing or disposal facilities shall include composting, incineration, pelletisation, energy recovery or any other facility based on state-of-the-art technology duly approved by the Central Pollution Control Board
2. In case of engagement of private agency by the municipal authority, a specific agreement between the municipal authority and the private agency shall be made particularly, for supply of solid waste and other relevant terms and conditions.
3. In order to prevent pollution problems from compost plant and other processing facilities, the following shall be complied with, namely: -

i. The incoming wastes at site shall be maintained prior to further processing. To the extent possible, the waste storage area should be covered. If, such storage is done in an open area, it shall be provided with impermeable base with facility for collection of leachate and surface water run-off into lined drains leading to a leachate treatment and disposal facility;

ii. Necessary precautions shall be taken to minimize nuisance of odour, flies, rodents, bird menace and fire hazard;

iii. In case of breakdown or maintenance of plant, waste intake shall be stopped and arrangements be worked out for diversion of wastes to the landfill site;

iv. Pre-process and post-process rejects shall be removed from the processing facility on regular basis and shall not be allowed to pile at the site. Recyclables shall be routed through appropriate vendors. The non-recyclables shall be sent for well-designed landfill site(s).

v. In case of compost plant, the windrow area shall be provided with impermeable base. Such a base shall be made of concrete or compacted clay, 50 cm thick, having permeability coefficient less than 10^{-7} cm/sec. The base shall be provided with 1 to 2 per cent slope and circled by lined drains for collection of leachate or surface run-off;

vi. Ambient air quality monitoring shall be regularly carried out particularly for checking odour nuisance at down-wind direction on the boundary of processing plant.

vii. In order to ensure safe application of compost, the following specifications for compost quality shall be met, namely:-

Parameters	**Concentration not to exceed * (mg/kg dry basis, except pH value and C/N ratio)**
Arsenic	10.00
Cadmium	5.00
Chromium	50.00

Copper	300.00
Lead	100.00
Mercury	0.15
Nickel	50.00
Zinc	1000.00
C/N ratio	20-40
PH	5.5-8.5

* Compost (final product) exceeding the above stated concentration limits shall not be used for food crops. However, it may be utilized for purposes other than growing food crops.

4. The disposal of treated leachate shall follow the following standards, namely: -

S.No	**Parameter**	**Standards (Mode of Disposal)**		
		Inland surface water	**Public sewers**	**Land disposal**
1.	Suspended solids, mg/l, max	100	600	200
2.	Dissolved solids (inorganic) mg/l, max.	2100	2100	2100
3	PH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
4	Ammonical nitrogen (as N), mg/l, max.	50	50	-
5	Total Kjeldahl nitrogen (as N), mg/l, max.	100	-	-
6	Biochemical oxygen demand (3 days at 27^0 C) max. (Mg/l)	30	350	100
7	Chemical oxygen demand, mg/l, max.	250	-	-
8	Arsenic (as As), mg/l, max	0.2	0.2	0.2

9	Mercury (as Hg), mg/l, max	0.01	0.01	-
10	Lead (as Pb), mg/l, max	0.1	1.0	-
11	Cadmium (as Cd), mg/l, max	2.0	1.0	-
12	Total Chromium (as Cr), mg/l, max.	2.0	2.0	-
13	Copper (as Cu), mg/l, max.	3.0	3.0	-
14	Zinc (as Zn), mg/l, max.	5.0	15	-
15	Nickel (as Ni), mg/l, max	3.0	3.0	-
16	Cyanide (as CN), mg/l, max.	0.2	2.0	0.2
17	Chloride (as Cl), mg/l, max.	1000	1000	600
18	Fluoride (as F), mg/l, max	2.0	1.5	-
19	Phenolic compounds (as C_6H_5OH) mg/l, max.	1.0	5.0	-

Note: While discharging treated leachates into inland surface waters, quantity of leachates being discharged and the quantity of dilution water available in the receiving water body shall be given due consideration.

The incinerators shall meet the following operating and emission standards, namely: -

A. Operating Standards

(1) The combustion efficiency (CE) shall be at least 99.00%.

(2) The combustion efficiency is computed as follows:

$$C.E. = \frac{\%CO_2}{\%CO_2 + \%CO} \times 100$$

1. Emission Standards

Parameters	Concentration mg/Nm^3 at (12% CO_2 correction)
(1) Particulate matter	150
(2) Nitrogen Oxides	450
(3) HCl	50
(4) Minimum stack height shall be 30 meters above ground.	
(5) Volatile organic compounds in ash shall not be more than	0.01%.

Note:

1. Suitably designed pollution control devices shall be installed or retrofitted with the incinerator to achieve the above emission limits, if necessary.
2. Astes to be incinerated shall not be chemically treated with any chlorinated disinfectants
3. Chlorinated plastics shall not be incinerated.
4. Toxic metals in incineration ash shall be limited within the regulatory quantities as specified in the Hazardous Wastes (Management and Handling) Rules, 1989 as amended from time to time.
5. Only low sulphur fuel like l.d.o., l.s.h.s or Diesel shall be used as fuel in the incinerator.

ANNEXURE IV
A Compilation of Legal Instruments

Sl. No.	Legal Instrument (Type, Reference, Year)	Responsible Ministries or Bodies	Chemical Use Categories/ Pollutants	Objective of Legislation	Relevant Articles/Provisions
1	Air (Prevention and Control of Pollution) Act, 1981 amended 1987	Central Pollution Control Board and State Pollution Control Boards	Air pollutants from chemical industries	The prevention, control and abatement of air pollution	Section 2: Definitions Section 21: Consent from State Boards Section 22: Not to allow emissions exceeding prescribed limits Section 24: Power of Entry and Inspection Section 25: Power to Obtain Information Section 26: Power to Take Samples Section 37-43: Penalties and Procedures
2	Air (Prevention and Control of Pollution) (Union Territories) Rules, 1983	Central Pollution Control Board and State Pollution Control Boards	Air pollutants from chemical industries	The prevention, control and abatement of air pollution	Rule 2: Definitions Rule 9: Consent Applications
3	Water (Prevention and Control of Pollution) Act, 1974 amended 1988	Central Pollution Control Board and State Pollution Control Boards	Water Pollutants from water polluting industries	The prevention and control of water pollution and also maintaining or restoring the wholesomeness of water	Section 2: Definitions Section 20: Power to Obtain Information Section 21: Power to Take Samples Section 23: Power of Entry and Inspection Section 24: Prohibition on Disposal Section 25: Restriction on New Outlet and New Discharge Section 26: Provision regarding existing discharge of sewage or trade effluent Section 27: Refusal or withdrawal of consent by state boards Section 41-49: Penalties and Procedures
4	Water (Prevention and Control of Pollution) Rules, 1975	Central Pollution Control Board and State Pollution Control Boards	Water Pollutants from water polluting industries	The prevention and control of water pollution and also maintaining or restoring the wholesomeness of water	Rule 2: Definitions Rule 30: Power to take samples Rule 32: Consent Applications
5	The Environment (Protection) Act, 1986,	Ministry of Environment and	All types of environmental pollutants	Protection and Improvement of the Environment	Section 2: Definitions Section 7: Not to allow emission or discharge of

Sl. No.	Legal Instrument (Type, Reference, Year)	Responsible Ministries or Bodies	Chemical Use Categories/ Pollutants	Objective of Legislation	Relevant Articles/Provisions
	amended 1991	Forests, Central Pollution Control Board and State Pollution Control Boards			environmental pollutants in excess of prescribed standards Section 8: Handing of Hazardous Substances Section 10: Power of Entry and Inspection Section 11: Power to take samples Section 15-19: Penalties and Procedures
6	Environmental (Protection) Rules, 1986 (Amendments in 1999, 2001, 2002, 2002, 2002, 2003, 2004)	Ministry of Environment and Forests, Central Pollution Control Board and State Pollution Control Boards	All types of Environmental Pollutants	Protection and Improvement of the Environment	Rule 2: Definitions Rule 3: Standards for emission or discharge of environmental pollutants Rule 5: Prohibition and restriction on the location of industries and the carrying on process and operations in different areas Rule 13: Prohibition and restriction on the handling of hazardous substances in different areas Rule 14: Submission of environmental statement
7	Manufacture Storage and Import of Hazardous Chemicals Rules, 1989 amended 2000	Ministry of Environment & Forests, Chief Controller of Imports and Exports, CPCB, SPCB, Chief Inspector of Factories, Chief Inspector of Dock Safety, Chief Inspector of Mines, AERB, Chief Controller of Explosives, District Collector or District	Hazardous Chemicals - Toxic, Explosive, Flammable, Reactive	Regulate the manufacture, storage and import of Hazardous Chemicals	Rule 2: Definitions Rule 4: responsibility of the Occupier Rule 5: Notification of Major Accidents Rule 7-8: Approval and notification of site and updating Rule 10-11: Safety Reports and Safety Audit reports and updating Rule 13: Preparation of Onsite Emergency Plan Rule 14: Preparation of Offsite Emergency Plan Rule 15: Information to persons likely to get affected Rule 16: Proprietary Information Rule 17: Material Safety Data Sheets Rule 18: Import of Hazardous Chemicals

Sl. No.	Legal Instrument (Type, Reference, Year)	Responsible Ministries or Bodies	Chemical Use Categories/ Pollutants	Objective of Legislation	Relevant Articles/Provisions
		Emergency Authority, CEES under DRDO			
8	Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	CCG, SCG, DCG, LCG and MAH Units	Hazardous Chemicals - Toxic, Explosive, Flammable, Reactive	Emergency Planning Preparedness and Response to chemical accidents	Rule 2: Definitions Rule 5: Functions of CCG Rule 7: Functions of SCG Rule 9: Functions of DCG Rule 10: Functions of LCG
9	Ozone Depleting Substances (Regulation and Control) Rules, 2000	Ministry of Environment & Forests	Ozone depleting substances	Regulate the production, import, use, sale, purchase and phase-out of the ODS	Rule 2: Definitions Rule 3: Regulation of production and consumption of ozone depleting substances Rule 4: Prohibition on export to or import from countries not specified in Schedule VI Rule 5: Ozone depleting substances are to be exported to or imported from countries specified in Schedule VI under a license Rule 6: Regulation of the sale of ozone depleting substances Rule 7: Regulation on the purchase of ozone depleting substances Rule 8: Regulation on the use of ozone depleting substance Rule 9: Prohibition on new investments with ozone depleting substances Rule 10: Regulation of import, export and sale of products made with or containing ozone depleting substances Rule 11: Regulation on reclamation and destruction of ozone depleting substances Rule 12: Regulation on manufacture, import and export of compressors Rule 13: Procedure for registration, cancellation of registration and appeal against such orders Rule 14: Monitoring and reporting requirements

Sl. No.	Legal Instrument (Type, Reference, Year)	Responsible Ministries or Bodies	Chemical Use Categories/ Pollutants	Objective of Legislation	Relevant Articles/Provisions
10	EIA Notification, 2006	MoEF, SPCB	For all the identified developmental activities in the notification	Requirement of environmental clearance before establishment of or modernization / expansion of identified developmental projects.	Requirements and procedure for seeking environmental clearance of projects
11	Public Liability Insurance Act, 1991 amended 1992	Ministry of Environment & Forests, District Collector	Hazardous Substances	To provide immediate relief to persons affected by accident involving hazardous substances	Section 2: Definitions Section 3: Liability to give relief in certain cases on principle of no fault Section 4: Duty of owner to take out insurance policy Section 7A: Establishment of Environmental Relief Fund Section 14-18: Penalties and Offences
13	Public Liability Insurance Rules, 1991 amended 1993	Ministry of Environment & Forests, District Collector	Hazardous Substances	To provide immediate relief to persons affected by accident involving hazardous substances and also for Establishing an Environmental Relief fund	Rule 2: Definitions Rule 6: Establishment of administration of fund Rule 10: Extent of liability Rule 11: Contribution of the owner to environmental relief fund
14	The Explosives Act, 1884	Ministry of Commerce and Industry (Department of Explosives)	Explosive substances as defined under the Act	To regulate the manufacture, possession, use, sale, transport, export and import of explosives with a view to prevent accidents	Section 4: Definition Section 6: Power for Central government to prohibit the manufacture, possession or importation of especially dangerous explosives Section 6B: Grant of Licenses
15	The Explosive Rules, 1983	Ministry of Commerce and Industry and Chief Controller of Explosives, port conservator, customs collector, railway administration	Explosive substances as defined under the Act	To regulate the manufacture, possession, use, sale, transport, export and import of explosives with a view to prevent accidents	Rule 2: Definition Chapter II: General Provisions Chapter III: Import and Export Chapter IV: Transport Chapter V: Manufacture of explosives Chapter VI: Possession sale and use Chapter VII: Licenses

Sl. No.	Legal Instrument (Type, Reference, Year)	Responsible Ministries or Bodies	Chemical Use Categories/ Pollutants	Objective of Legislation	Relevant Articles/Provisions
16	The Static and Mobile Pressure Vessels (Unfired) Rules, 1981	Ministry of Commerce and Industry and Chief Controller of Explosives, port conservator, customs collector, DGCA, DC, DM, Police (sub inspector to commissioner)	Gases (Toxic, non toxic and non flammable, non toxic and flammable, Dissolved Acetylene Gas, Non toxic and flammable liquefiable gas other than LPG, LPG	Regulate the import, manufacture, design, installation, transportation, handling, use and testing of mobile and static pressure vessels (unfired) with a view to prevent accidents	Rule 2: Definition Chapter III: Storage Chapter IV: Transport Chapter V: Licenses

ANNEXURE V
General Standards for Discharge of Environmental Pollutants as per CPCB

Table: Water Quality Standards

S. No.	Parameter	Standards			
		Inland Surface Water	Public Sewer	Land for Irrigation	Marine Coastal Areas
1.	2.	3.			
		(a)	(b)	(c)	(d)
1.	Colour and odour	See Note-1	—	See Note-1	See Note-1
2.	Suspended Solids, mg/l, Max	100	600	200	(a) For process waste water-100 (b) For cooling water effluent-10 per cent above total suspended matter of influent cooling water.
3.	Particle size of suspended solids	Shall pass 850 micron IS Sieve	—	—	(a) Floatable solids, Max 3 mm (b) Settleable solids Max 850 microns.
4.	Dissolved solids (inorganic), mg/a, mac	2100	2100	2100	—
5.	pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
6.	Temperature ^{o}C, Max	Shall not exceed 40 in any section of the stream within 15 meters down stream from the effluent outlet	45 at the point of discharge	—	45 at the point of discharge
7.	Oil and grease, mg/l, max	10	20	10	20
8.	Total residual chlorine, mg/l, Max.	1.0	—	—	1.0
9.	Ammonical nitrogen (as N), mg/l, Max.	50	50	—	50
10.	Total Kjeldahl nitrogen (as N), mg/l, Max.	100	—	—	100
11.	Free Ammonia (as NH3), mg/l, Max.	5.0	—	—	5.0
12.	Biochemical Oxygen Demand (5 days at 20^{o}C) Max.	30	350	100	100
13.	Chemical Oxygen Demand, mg/l, Max.	250	—	—	250
14.	Arsenic (as As), mg/l, Max.	0.2	0.2	0.2	0.2
15.	Mercury (as Hg), mg/l, Max.	0.01	0.01	—	0.01
16.	Lead (as Pb), mg/l, Max.	0.1	1.0	—	1.0
17.	Cadmium (as Cd), mg/l, Max.	2.0	1.0	—	2.0

S. No.	Parameter	Standards			
		Inland Surface Water	Public Sewer	Land for Irrigation	Marine Coastal Areas
1.	2.	3.			
		(a)	(b)	(c)	(d)
18.	Hexavalent chromium (as Cr+6) mg/l, Max.	0.1	2.0	—	1.0
19.	Total chromium as (Cr), mg/l, Max.	2.0	2.0	—	2.0
20.	Copper (as Cu), mg/l, Max.	3.0	3.0	—	3.0
21.	Zinc (as Zn), mg/l, Max.	5.0	15	—	15
22.	Selenium (as Se), mg/l, Max.	0.05	0.05	—	0.05
23.	Nickel (as Ni), mg/l, Max.	3.0	3.0	—	5.0
24.	Boron (as B), mg/l, Max.	2.0	2.0	2.0	—
25.	Percent Sodium, Max.	—	60	60	—
26.	Residual sodium carbonate, mg/l, Max.	—	—	5.0	—
27.	Cyanide (as CN), mg/l, Max.	0.2	2.0	0.2	0.2
28.	Chloride (as Cl), mg/l, Max.	1000	1000	600	(a)
29.	Fluoride (as F), mg/l, Max.	2.0	15	—	15
30.	Dissolved Phosphates (as P), mg/l, Max.	5.0	—	—	—
31.	Sulphate (as SO4), mg/l, Max.	1000	1000	1000	—
32.	Sulphide (as S), mg/l, Max.	2.0	—	—	5.0
33.	Pesticides	Absent	Absent	Absent	Absent
34.	Phenolic compounds (as C6H5OH), mg/l, Max.	1.0	5.0	—	5.0
35.	Radioactive materials (a) Alpha emitters MC/ml, Max. (b) Beta emitters uc/ml, Max.	10^{-7} 10^{-6}	10^{-7} 10^{-6}	10^{-8} 10^{-7}	10^{-7} 10^{-6}

Note :-

1. All efforts should be made to remove colour and unpleasant odour as far as practicable.
2. The standards mentioned in this notification shall apply to all the effluents discharged such as industrial mining and mineral processing activities municipal sewage etc.

Table: Noise Standards

Ambient air quality standards in respect of noise

Area Code	Category of Area	Limits in dB (A) Leq	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence zone	50	40

Note :

1. Day time is reckoned in between 6.00 AM and 9.00 PM
2. Night time is reckoned in between 9.00 PM and 6.00 AM
3. Silence zone is defined as areas upto 100 meters around such premises as hospitals, educational institutions and courts. The Silence zones are to be declared by the Competent Authority.
4. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
5. Mixed categories of areas should be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply.

Standards/Guidelines for Control of Noise Pollution from Stationary Diesel Generator (DG) Sets

(A) Noise Standards for DG Sets (15-500 KVA)

The total sound power level, Lw, of a DG set should be less than, 94+10 log10 (KVA), dB (A), at the manufacturing stage, where, KVA is the nominal power rating of a DG set.

This level should fall by 5 dB (A) every five years, till 2007, i.e. in 2002 and then in 2007.

(B) Mandatory acoustic enclosure/acoustic treatment of room for stationary DG sets (5 KVA and above)

Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the room acoustically.

The acoustic enclosure/acoustic treatment of the room should be designed for minimum 25 dB(A) Insertion Loss or for meeting the ambient noise standards, whichever is on the higher side (if the actual ambient noise is on the higher side, it may not be possible to check the performance of the acoustic enclosure/acoustic treatment. Under such circumstances the performance may be checked for noise reduction upto actual ambient noise level, preferably, in the night time). The measurement for Insertion Loss may be done at different points at 0.5m from the acoustic enclosure/room, and then averaged.

The DG set should also be provide with proper exhaust muffler with Insertion Loss of minimum 25 dB(A).

(C) Guidelines for the manufacturers/users of DG sets (5 KVA and above)

1. The manufacturer should offer to the user a standard acoustic enclosure of 25 dB(A) Insertion Loss and also a suitable exhaust muffler with Insertion Loss of 25 dB(A).

2. The user should make efforts to bring down the noise levels due to the DG set, outside his premises, within the ambient noise requirements by proper siting and control measures.
3. The manufacturer should furnish noise power levels of the unlicensed DG sets as per standards prescribed under (A)
4. The total sound power level of a DG set, at the user's end, shall be within 2 dB(A) of the total sound power level of the DG set, at the manufacturing stage, as prescribed under (A).
5. Installation of a DG set must be strictly in compliance with the recommendation of the DG set manufacturer.
6. A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

Order of the Lt. Governor of Delhi in respect of D.G. Sets (5th December, 2001)

In exercise of the powers conferred by section 5 of the Environment (Protection) Act, 1986, (29 of 1986), read with the Government of India, Ministry of Home Affairs notification S.O. 667 (E) bearing No. F.No. U-11030/J/91-VTL dated 10th September, 1992, the Lt. Governor of Government of National Capital of Delhi hereby directs to all owners/users of generators sets in the National Capital Territory of Delhi as follows :-

1. that generator sets above the capacity of 5 KVA shall not be operated in residential areas between the hours of 10.00 PM to 6.00 AM;
2. that the generator sets above the capacity of 5 KVA in all areas residential/commercial/industrial shall operate only with the mandatory acoustic enclosures and other standards prescribed in the Environment (Protection) Rules, 1986;
3. that mobile generator sets used in social gatherings and public functions shall be permitted only if they have installed mandatory acoustic enclosures and adhere to the prescribed standards for noise and emission as laid down in the Environment (Protection) Rules, 1986.

The contravention of the above directions shall make the offender liable for prosecution under section 15 of the said Act which stipulates punishment of imprisonment for a term which may extend to five years with fine which may extend to one lakh rupees, or with both, and in case the failure of contravention continues, with additional fine which may extend to five thousand rupees for every day during which such failure or contravention continues after the conviction for the first such failure or contravention and if still the failure or contravention continues beyond a period of one year after the date of contravention, the offender continues beyond a period of one year after the date of contravention, the offender shall be punishable with imprisonment for a term which may extend to seven years.

Order Dated: 21st June, 2002

In exercise of the powers conferred by section 5 of the Environment (Protection) Act, 1986 (29 of 1986) read with the Govt. of India, Ministry of Home Affairs notification S.O. 667(E) bearing No. U-11030/J/91-VTL dated the 10th September, 1992, the Lt. Governor Govt. of the National Capital Territory of Delhi hereby makes the following amendment/modification in his order dated the 5th December, 2001 regarding the operation of generator sets, namely:-

Amendments/modifications

In the above said order, for clause(1), the following shall be substituted, namely:-

"(1) that the generator sets above 5KVA shall not be operated in residential areas between the hours from 10.00 p.m. to 6.00 a.m. except generator sets of Group Housing Societies and Multi-storey residential apartments".

DIESEL GENERATOR SETS: STACK HEIGHT

The minimum height of stack to be provided with each generator set can be worked out using the following formula:

$H = h + 0.2 \times \sqrt{KVA}$

H = Total height of stack in metre

h = Height of the building in metres where the generator set is installed

KVA = Total generator capacity of the set in KVA

Based on the above formula the minimum stack height to be provided with different range of generator sets may be categorized as follows:

For Generator Sets	Total Height of stack in metre
50 KVA	Ht. of the building + 1.5 metre
50-100 KVA	Ht. of the building + 2.0 metre
100- 150 KVA	Ht. of the building + 2.5 metre
150-200 KVA	Ht. of the building + 3.0 metre
200-250 KVA	Ht. of the building + 3.5 metre
250-300 KVA	Ht. of the building + 3.5 metre

Similarly for higher KVA ratings a stack height can be worked out using the above formula

Source: Evolved By CPCB

[Emission Regulations Part IV: COINDS/26/1986-87]

ANNEXURE VI
FCO Standards for Compost Quality

Fertilizer Control Order (FCO) Standards for Compost Quality

S.NO	TESTS	LIMIT
1	**Moisture %**	15.0 - 25.0
2	**Colour**	Dark Brown to Black
3	**Odour**	Absence of foul odour
4	**Particle Size**	Minimum 90% material should pass through the 4mm sieve
5	**Bulk Density(g/cm$^{3)}$**	0.7 - 0.9
6	**Total Organic carbon %**	16
7	**Total Nitrogen(as n) %**	0.5
8	**Total Phosphate (P_2O_5)**	0.5
9	**Total Potash (as K_2O)**	1
10	**C:N ratio**	20:1 or less
11	**pH**	6.5 - 7.5
12	**Conductivity**	4
13	**Pathogens**	Nil
14	**Heavy Metal Content %**	
	Arsenic(as As_2O_3)	10
	Cadmium (as Cd)	5
	Chromium (as Cr)	50
	Copper (as Cu)	300
	Mercury(as Hg)	0.15
	Nickel (as Ni)	50
	Lead (as Pb)	100
	Zinc(as Zn)	1000

ANNEXURE VII
Form 1 (Application Form for Obtaining EIA Clearance)

FORM 1

(I) BASIC INFORMATION

S. No.	Item	Details
1.	Name of the project/s	
2.	S.No. in the schedule	
3.	Proposed capacity/area/length/tonnage to be handled/command area/lease area/number of wells to be drilled	
4.	New/Expansion/Modernization	
5.	Existing Capacity/Area etc.	
6.	Category of Project i.e., 'A' or 'B'	
7.	Does it attract the general condition? If yes, please specify.	
8.	Does it attract the specific condition? If yes, Please specify.	
9.	Location	
	Plot/Survey/Khasra No.	
	Village	
	Tehsil	
	District	
	State	
10.	Name of the applicant	
11.	Registered Address	
12.	Address for correspondence:	
	Name	
	Designation (Owner/Partner/CEO)	
	Address	
	Pin Code	
	E-mail	
	Telephone No.	
	Fax No.	
13.	Details of alternative Sites examined, if any location of these sites should be shown on a toposheet.	Village-District-State 1. 2. 3.

S. No.	Item	Details
14.	Interlined Projects	
15.	Whether separate application of interlined project has been submitted	
16.	If yes, date of submission	
17.	If no, reason	
18.	Whether the proposal involves approval/clearance under: The Forest (Conservation) Act, 1980 The Wildlife (Protection) Act, 1972 The C.R.Z. Notification, 1991	
19.	Forest land involved (hectares)	
20.	Whether there is any litigation pending against the project and/or land in which the project is propose to be set up Name of the Court Case No. Orders/directions of the Court, if any and its relevance with the proposed project.	

(II) ACTIVITY

1. Construction, operation or decommissioning of the Project involving actions, which will cause physical changes in the locality (topography, land use, changes in water bodies, etc.)

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
1.1	Permanent or temporary change in land use, land cover or topography including increase in intensity of land use (with respect to local land use plan)		
1.2	Clearance of existing land, vegetation and buildings?		
1.3	Creation of new land uses?		
1.4	Pre-construction investigations e.g. bore houses, soil testing?		
1.5	Construction works?		

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
1.6	Demolition works?		
1.7	Temporary sites used for construction works or housing of construction workers?		
1.8	Above ground buildings, structures or earthworks including linear structures, cut and fill or excavations		
1.9	Underground works including mining or tunneling?		
1.10	Reclamation works?		
1.11	Dredging?		
1.12	Offshore structures?		
1.13	Production and manufacturing processes?		
1.14	Facilities for storage of goods or materials?		
1.15	Facilities for treatment or disposal of solid waste or liquid effluents?		
1.16	Facilities for long term housing of operational workers?		
1.17	New road, rail or sea traffic during construction or operation?		
1.18	New road, rail, air waterborne or other transport infrastructure including new or altered routes and stations, ports, airports etc?		
1.19	Closure or diversion of existing transport routes or infrastructure leading to changes in traffic movements?		
1.20	New or diverted transmission lines or pipelines?		
1.21	Impoundment, damming, culverting, realignment or other changes to the hydrology of watercourses or aquifers?		
1.22	Stream crossings?		
1.23	Abstraction or transfers of water form ground or surface waters?		
1.24	Changes in water bodies or the land surface affecting drainage or run-off?		
1.25	Transport of personnel or materials for construction, operation or decommissioning?		

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
1.26	Long-term dismantling or decommissioning or restoration works?		
1.27	Ongoing activity during decommissioning which could have an impact on the environment?		
1.28	Influx of people to an area in either temporarily or permanently?		
1.29	Introduction of alien species?		
1.30	Loss of native species or genetic diversity?		
1.31	Any other actions?		

2. Use of Natural resources for construction or operation of the Project (such as land, water, materials or energy, especially any resources which are non-renewable or in short supply):

S.No.	Information/checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
2.1	Land especially undeveloped or agricultural land (ha)		
2.2	Water (expected source & competing users) unit: KLD		
2.3	Minerals (MT)		
2.4	Construction material – stone, aggregates, sand / soil (expected source – MT)		
2.5	Forests and timber (source – MT)		
2.6	Energy including electricity and fuels (source, competing users) Unit: fuel (MT), energy (MW)		
2.7	Any other natural resources (use appropriate standard units)		

3. Use, storage, transport, handling or production of substances or materials, which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health.

S.No	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
3.1	Use of substances or materials, which are hazardous (as per MSIHC rules) to human health or the environment (flora, fauna, and water supplies)		
3.2	Changes in occurrence of disease or affect disease vectors (e.g. insect or water borne diseases)		
3.3	Affect the welfare of people e.g. by changing living conditions?		
3.4	Vulnerable groups of people who could be affected by the project e.g. hospital patients, children, the elderly etc.,		
3.5	Any other causes		

4. Production of solid wastes during construction or operation or decommissioning (MT/month)

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
4.1	Spoil, overburden or mine wastes		
4.2	Municipal waste (domestic and or commercial wastes)		
4.3	Hazardous wastes (as per Hazardous Waste Management Rules)		
4.4	Other industrial process wastes		
4.5	Surplus product		
4.6	Sewage sludge or other sludge from effluent treatment		
4.7	Construction or demolition wastes		
4.8	Redundant machinery or equipment		

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
4.9	Contaminated soils or other materials		
4.10	Agricultural wastes		
4.11	Other solid wastes		

5. Release of pollutants or any hazardous, toxic or noxious substances to air (kg/hr)

S.No	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
5.1	Emissions from combustion of fossil fuels from stationary or mobile sources		
5.2	Emissions from production processes		
5.3	Emissions from materials handling including storage or transport		
5.4	Emissions from construction activities including plant and equipment		
5.5	Dust or odours from handling of materials including construction materials, sewage and waste		
5.6	Emissions from incineration of waste		
5.7	Emissions from burning of waste in open air (e.g. slash materials, construction debris)		
5.8	Emissions from any other sources		

6. Generation of Noise and Vibration, and Emissions of Light and Heat:

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data with source of information data
6.1	From operation of equipment e.g. engines, ventilation plant, crushers		
6.2	From industrial or similar processes		
6.3	From construction or demolition		
6.4	From blasting or piling		
6.5	From construction or operational traffic		
6.6	From lighting or cooling systems		
6.7	From any other sources		

7. Risks of contamination of land or water from releases of pollutants into the ground or into sewers, surface waters, groundwater, coastal waters or the sea:

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
7.1	From handling, storage, use or spillage of hazardous materials		
7.2	From discharge of sewage or other effluents to water or the land (expected mode and place of discharge)		
7.3	By deposition of pollutants emitted to air into the land or into water		
7.4	From any other sources		
7.5	Is there a risk of long term build up of pollutants in the environment from these sources?		

8. Risk of accidents during construction or operation of the Project, which could affect human health or the environment

S.No	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
8.1	From explosions, spillages, fires etc from storage, handling, use or production of hazardous substances		
8.2	From any other causes		
8.3	Could the project be affected by natural disasters causing environmental damage (e.g. floods, earthquakes, landslides, cloudburst etc)?		

9. Factors which should be considered (such as consequential development) which could lead to environmental effects or the potential for cumulative impacts with other existing or planned activities in the locality

S. No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
9.1	Lead to development of supporting facilities, ancillary development or development stimulated by the project which could have impact on the environment e.g.: ▪ Supporting infrastructure (roads, power supply, waste or waste water treatment, etc.) ▪ housing development ▪ extractive industries ▪ supply industries ▪ other		
9.2	Lead to after-use of the site, which could have an impact on the environment		
9.3	Set a precedent for later developments		
9.4	Have cumulative effects due to proximity to other existing or planned projects with similar effects		

(III) ENVIRONMENTAL SENSITIVITY

S.No.	Areas	Name/ Identity	Aerial distance (within 15 km.) Proposed project location boundary
1	Areas protected under international conventions, national or local legislation for their ecological, landscape, cultural or other related value		
2	Areas which are important or sensitive for ecological reasons - Wetlands, watercourses or other water bodies, coastal zone, biospheres, mountains, forests		
3	Areas used by protected, important or sensitive species of flora or fauna for breeding, nesting, foraging, resting, over wintering, migration		
4	Inland, coastal, marine or underground waters		
5	State, National boundaries		
6	Routes or facilities used by the public for access to recreation or other tourist, pilgrim areas		
7	Defence installations		
8	Densely populated or built-up area		
9	Areas occupied by sensitive man-made land uses *(hospitals, schools, places of worship, community facilities)*		
10	Areas containing important, high quality or scarce resources *(ground water resources, surface resources, forestry, agriculture, fisheries, tourism, minerals)*		
11	Areas already subjected to pollution or environmental damage. *(those where existing legal environmental standards are exceeded)*		
12	Areas susceptible to natural hazard which could cause the project to present environmental problems (*earthquakes, subsidence, landslides, erosion, flooding or extreme or adverse climatic conditions*)		

(IV) PROPOSED TERMS OF REFERENCE FOR EIA STUDIES

"I hereby given undertaking that the data and information given in the application and enclosure are true to the best of my knowledge and belief and I am aware that if any part of the data and information submitted is found to be false or misleading at any stage, the project will be rejected and clearance give, if any to the project will be revoked at our risk and cost.

Date:_____
Place:_____

Signature of the applicant
With Name and Full Address
(Project Proponent / Authorized Signatory)

NOTE:

1. The projects involving clearance under Coastal Regulation Zone Notification, 1991 shall submit with the application a C.R.Z. map duly demarcated by one of the authorized, agencies, showing the project activities, w.r.t. C.R.Z. and the recommendations of the State Coastal Zone Management Authority. Simultaneous action shall also be taken to obtain the requisite clearance under the provisions of the C.R.Z. Notification, 1991 for the activities to be located in the CRZ.
2. The projects to be located within 10km of the National Parks, Sanctuaries, Biosphere Reserves, Migratory Corridors of Wild Animals, the project proponent shall submit the map duly authenticated by Chief Wildlife Warden showing these features vis-à-vis the project location and the recommendations or comments of the Chief Wildlife Warden thereon."

ANNEXURE VIII
Critically Polluted Industrial Areas and Clusters/Potential Impact Zones

Table 1: Details of Critically Polluted Industrial Areas and Clusters / Potential Impact Zone (Ref: Office Memorandum No. J-11013/5/2010-IA.II(I) Dated 13.1.2010)

S. No.	Critically Polluted Industrial Area and CEPI	Industrial Clusters/ Potential Impact Zones
1.	Ankeshwar (Gujarat) CEPI-88.50(Ac_Wc_Lc)	▪ GIDC Ankeshwar and GIDC, Panoli
2	Vapi (Gujarat) CEPI-88.09(Ac_Wc_Lc)	▪ GIDC Vapi
3	Ghaziabad (Uttar Pradesh) CEPI-87.37(Ac_Wc_Lc)	Sub-cluster A ▪ Mohan nagar industrial area ▪ Rajinder nagar industrial area ▪ Sahibabad industrial area Sub-cluster B ▪ Pandav nagar industrial area ▪ Kavi nagar industrial area ▪ Bulandshahar road industrial area ▪ Amrit nagar ▪ Aryanagar industrial area Sub-cluster C ▪ Merrut road industrial are Sub-cluster D ▪ Loni industrial area ▪ Loni Road industrial area ▪ Roop nagar industrial area Sub-cluster E ▪ Hapur Road industrial area ▪ Dasna ▪ Philkura Sub-cluster F (Other scattered industrial areas) ▪ South side of GT road ▪ Kavi Nagar ▪ Tronica city ▪ Anand Nagar ▪ Jindal Nagar ▪ Prakash Nagar ▪ Rural industrial estate
4	Chandrapur (Maharashtra) CEPI-83.88 (Ac_Wc_Lc)	▪ Chandrapur (MIDC Chandrapur, Tadali, Ghuggus, Ballapur)
5	Kobra (Chhatisgarh) CEPI-83.00 (Ac_Ws_Lc)	▪ Industrial areas and their townships of NTPC, BALCO, CSEB (East) & CSEB (West) ▪ Korba town
6	Bhiwadi (Rajasthan) CEPI-82.91 (Ac_Wc_Ls)	▪ RIICO industrial areas Phase I to IV ▪ Bhiwadi town ▪ Other surrounding industrial areas: Chopanki, Rampura Mundana, Khuskhera Phase I to III
7	Angul Talcer(Orissa) CEPI-82.09 (Ac_Wc_Lc)	▪ MCL Coal mining area, Augul – Talcer region ▪ Industrial area (60 km x 45 km) Following blocks of Augul district: ▪ Kohina block ▪ Talcher block

S. No.	Critically Polluted Industrial Area and CEPI	Industrial Clusters/ Potential Impact Zones
		▪ Angul block ▪ Chhendipada block ▪ Banarpal block ▪ Odapada block of Dhenkamal district
8	Vellore (North Arcot) (Tamil Nadu) CEPI-81.79 (Ac_Wc_Lc)	▪ Ranipet, SIPCOT industrial complex
9	Singrauli (Uttar Pradesh) CEPI-81.73 (Ac_Wc_Ls)	Sonebhadra (UP) ▪ Dala-Tola ▪ Obra ▪ Renukoot ▪ Anpara ▪ Renusagar ▪ Kakri ▪ Dudhichuwa ▪ Bina ▪ Khadia ▪ Shakti nagar ▪ Rihand nagar ▪ Bijpur Sigrauli (Madhya Pradesh) Vindhyachal nagar and Jaynat, Nigahi, Dudhichua, Amlohri & Jhingurdah townships
10	Ludhiana (Punjab) CEPI-81.66 (Ac_Wc_Ls)	Ludhiana municipal limits covering industrial clusters: ▪ Focal point along with NH-I- Total eight phase ▪ Industrial area-B- from sherpur chowk to Gill road & Gill road to Miller Kotla road (left side of road) ▪ Mixed industrial area – right side of Gill road ▪ Industrial area –C (near Juglana village) ▪ Industrial area A & extension: area between old GT road and Ludhiana bypass road ▪ Industrial estate: near Dholwal chowk ▪ Mixes industrial area (MIA) Miller gunj ▪ MIA – bypass road ▪ Bahdur industrial area ▪ Tejpur industrial complex
11	Nazafgarh drain basin, Delhi CEPI-79.54 (As_Wc_Lc)	▪ Industrial areas: Anand Parvat, Naraina, Okhla and Wazirpur
12	Noida (Uttar Pradesh) CEPI-78.90 (Ac_Wc_Lc)	Territorial Jurisdiction of: ▪ Noida Phase-1 ▪ Noida Phase-2 ▪ Noida Phase-3 ▪ Surajpur industrial area ▪ Greater Noida industrial area ▪ Village- Chhaparaula
13	Dhanbad (Jharkhand) CEPI-78.63 (Ac_Ws_Lc)	Four blocks of Dhanbad district: ▪ Sadar (Dhanbad Municipality) ▪ Jharia (Jharia Municipality, Sindri industrial area) ▪ Govindpur (Govindpur industrial estate) ▪ Nirsa

S. No.	Critically Polluted Industrial Area and CEPI	Industrial Clusters/ Potential Impact Zones
14	Dombivalli (Maharashtra) CEPI-78.41 (Ac_Wc_Ls)	▪ MIDC Phase- I, Phase- II
15	Kanpur (Uttar Pradesh) CEPI-78.09 (Ac_Wc_Ls)	Industrial areas: ▪ Dada nagar ▪ Panki ▪ Fazalganj ▪ Vijay nagar ▪ Jajmau
16	Cuddalore (Tamil Nadu) CEPI-77.45 (As_Wc_Lc)	▪ SIPCOT industrial complex, Phase I & II
17	Aurangabad (Maharashtra) CEPI-77.44 (Ac_Wc_Ls)	▪ MIDC Chikhalthana, MIDC Waluj, MIDC Shendra, and Paithan road industrial area
18	Faridabad (Haryana) CEPI-77.07 (Ac_Ws_Lc)	▪ Sector 27-A, B, C, D ▪ DLF phase- 1, sector 31,32 ▪ DLF phase- 2, sector 35 ▪ Sector 4, 6, 24, 27, 31, 59 ▪ Industrial area Hatin ▪ Industrial model township
19	Agra (Uttar Pradesh) CEPI-76.48 (As_Wc_Ls)	▪ Nunihai industrial estate, Rambag nagar, UPSIDC industrial area, and Runukata industrial area
20	Manali (Tamil Nadu) CEPI-76.32 (Ac_Ws_Ls)	▪ Manali industrial area
21	Haldia (West Bengal) CEPI-75.43 (As_Wc_Ls)	▪ 5 km wide strip (17.4 x 5.0 km) of industrial area on the southern side of the confluence point of Rivers Hugli and Rupnarayan, covering ▪ Haldia municipal area & Sutahata block – I and II
22	Ahmedabad (Gujarat) CEPI-75.28 (Ac_Ws_Ls)	▪ GIDC Odhav ▪ GIDC Naroda
23	Jodhpur (Rajasthan) CEPI-75.19 (As_Wc_Ls)	▪ Industrial areas including Basni areas (phase-I & II), industrial estate, light & heavy industrial areas, industrial areas behind new power house, Mandore, Bornada, Sangariya and village Tanwada & Salawas. ▪ Jodhpur city
24	Greater Cochin (Kerala) CEPI-75.08 (As_Wc_Ls)	▪ Eloor-Edayar industrial belt, ▪ Ambala Mogal industrial areas
25	Mandi Gobind Garh (Punjab) CEPI-75.08 (Ac_Ws_Lc)	▪ Mandi Govindgarh municipal limit and khanna area
26	Howrah (West Bengal) CEPI-74.84 (As_Ws_Lc)	▪ Liluah-Bamangachhi region, Howrah ▪ Jalan industrial complex-1, Howrah
27	Vatva (Gujarat) CEPI-74.77 (Ac_Wc_Ls)	▪ GIDC Vatva, Narol industrial area (Villages Piplaj, Shahwadi, Narol)
28	Ib Valley (Orissa) CEPI-74.00 (Ac_Ws_Ls)	▪ Ib Valley of Jharsuguda (Industrial and mining area)
29	Varansi-Mirzapur (Uttar Pradesh) CEPI-73.79 (As_Wc_Ls)	▪ Industrial estate, Mirzapur ▪ Chunar ▪ Industrial estate, Chandpur, Varansi

S. No.	Critically Polluted Industrial Area and CEPI	Industrial Clusters/ Potential Impact Zones
		▪ UPSIC, industrial estate, Phoolpur ▪ Industrial area, Ramnagar, Chandauli
30	Navi Mumbai (Maharashtra) CEPI-73.77 (Ac_Ws_Ls)	▪ TTC industrial area, MIDC, Navi Mumbai (including Bocks-D, C, EL, A, R, General, Kalva)
31	Pali (Rajasthan) CEPI-73.73 (As_Wc_Ls)	▪ Existing industrial areas: Mandia road, Puniyata road, Sumerpur ▪ Pali town
32	Mangalore (Karnataka) CEPI-73.68 (Ac_Ws_Ls)	▪ Baikampady industrial area
33	Jharsuguda (Orissa) CEPI-73.34 (Ac_Ws_Ls)	▪ Ib valley of Jharsuguda (Industrial and mining area)
34	Coimbatore (Tamil Nadu) CEPI-72.38 (Ac_Ws_Ln)	▪ SIDCO, Kurichi industrial Clusters
35	Bhadravati (Karnataka) CEPI-72.33 (Ac_Ws_Ln)	▪ KSSIDC Industrial area, Mysore paper mill & VISL township complex
36	Tarapur (Maharashtra) CEPI-72.01 (Ac_Ws_Ls)	▪ MIDC Tarapur
37	Panipat (Haryana) CEPI-71.91 (As_Ws_Ls)	▪ Panipat municipal limit and its industrial clusters
38	Indore (Madhya Pradesh) CEPI-71.26 (As_Ws_Ls)	Following 09 industrial area: ▪ Sanwer road ▪ Shivaji nagar ▪ Pologround ▪ Laxmibai nagar ▪ Scheme no.71 ▪ Navlakha ▪ Pipliya ▪ Palda ▪ Rau Indore city Other surrounding industrial areas: Manglia, Rajoda, Asrawad, Tejpur Gadwadi
39	Bhavnagar (Gujarat) CEPI-70.99 (As_Ws_Ls)	▪ GIDI Chitra, Bhavnagar
40	Vishakhapatnam (Andhra Pradesh) CEPI-70.82 (As_Ws_Ls)	▪ Bowl area (the area between Yarada hill range in the south to Simhachalam hill range in the north and sea on the east and the present NH-5 in the west direction)
41	Junagarh (Gujarat) CEPI-70.82 (As_Ws_Ls)	Industrial areas: ▪ Sabalpur ▪ Jay Bhavani ▪ Jay Bhuvneshwari ▪ GIDC Junagarh (I&II)
42	Asansole (West Bengal) CEPI-70.20 (As_Ws_Ls)	▪ Bumpur area surrounding IISCO
43	Patancheru - Bollaram (Andhra Pradesh)	Industrial area: ▪ Patancheru ▪ Bollaram

S. No.	Critically Polluted Industrial Area and CEPI	Industrial Clusters/ Potential Impact Zones
	CEPI-70.07 (As_Ws_Ls)	

Note:

Names of identified industrial clusters/potential impact zones are approximate location based on rapid survey and assessment and may alter partially subject to the detailed field study and monitoring. Detailed mapping will be made available showing spatial boundaries of the identified industrial clusters including zone of influence/ buffer zone, after in depth field study.

ANNEXURE IX
Pre-Feasibility Report: Points for Possible Coverage

Table 1: Points for Possible Coverage in Pre-feasibility Report

S. No.	Contents	Points of Coverage in Pre-feasibility Report
I.	**Executive summary**	▪ A miniature report of entire pre feasibility report.
II.	**Project Details**	
	Need/Justification of the Project	▪ Need for waste management and establishing the waste management facilities ▪ Alternatives to meet the need ▪ Post project scenario , *etc*.
	Profile of Project Area	▪ City/ULB Profile ▪ Location/ Landuse (Study area as well as City/ULB) - Geographical details - Longitude & latitude, village, taluka, district, state - In case of seismic areas, seismic zone, active faults, occurrence on earthquakes, *etc*. - Proximity from infrastructural facilities - Landuse pattern such as agricultural, barren, forest, *etc*. and details thereof - Topography of the area - Approach to site – roads, railways and airports - Distance from nearest residential and industrial areas - Distance from nearest water bodies such as river, canal, dam, *etc* - Distance from ecologically sensitive areas - In case of flood prone areas, HFL of the site - Drainage patterns, *etc* ▪ Climatic conditions (Meteorology) ▪ Area & population (also provide details of slums) ▪ Population projections ▪ Population density, *etc.*
	Current waste management Scenario	▪ Details on waste quantity, composition and waste generation rates, leachate quantity & quality *etc* ▪ Solid waste collection system ▪ Solid waste transfer and transport ▪ Storage, treatment and disposal details ▪ SWM organisation, *etc.*
	Baseline Studies - Parameters for Study	▪ Micro-meteorology ▪ Air Environment ▪ Water Environment ▪ Noise Environment ▪ Traffic studies ▪ Land Environment ▪ Ecological Environment ▪ Socio-economic Environment, *etc.*
III	**Proposed Solid Waste Management Facilities**	
	Technical profile	▪ Various activities of the proposed MSW facility - Waste Handling, Sorting, Storage & Processing At Source - Collection of MSW - Door-to-door collection - Transfer and Transport - Transfer station - Traffic that would arise during different phases of the project and transportation mechanism to handle such traffic

		▪ New facilities needed ▪ Technical parameters of the facility & equipments to be used, *etc.*
	Process technology	▪ Analysis of all available technologies and better operating practices. ▪ Analysis of various possible configurations for each technology or a combination of these technologies for waste management ▪ Optimization of facility capacity and area ▪ Broad specifications for the proposed facility including: - Design, construction, operation process for each alternative - In case of landfill, details on landfill type, construction and phases, waste storage, leachate management, landfill gas management, stormwater management, *etc*. - Equipments used at the facility for handling waste - General facility layout showing all the units, *etc*.
	Resources	▪ Manpower ▪ Equipments for handling waste ▪ Transportation vehicles ▪ Construction material ▪ Infrastructure development ▪ Power ▪ Source of water for utilities, domestic, *etc*.
	Project schedule	▪ Project implementation schedule
	Project Cost	▪ Ascertain the costs and benefits of the proposed project for project life ▪ Technical and logistic constraints/requirements of project sustainability, *etc.*
III.	**Selection of site based on least possible impacts (New MSW Facilities)**	
i.	**Choice of site selection**	
	Land details	▪ Land requirement and availability ▪ Land ownership details such as Government, private, tribal, non-tribal, *etc*. ▪ Total area of the project/site ▪ Prevailing land cost details, *etc.*
	Major techno-economic feasibility considerations	▪ Land availability & its development ▪ Product demand around the selected site ▪ Access to site for transportation of equipments/ construction machinery, material, *etc*. ▪ Raw material availability and its transportation ▪ Water availability and consumptive use ▪ Product transportation ▪ Infrastructure availability at selected site ▪ Inter-state issue, if any, *etc.*
	Incompatible landuse and ecologically sensitive attributes with respect to identified suitable sites	▪ If any incompatible land-use attributes fall within the study area, the following details has to be provided: - Public water supply areas from rivers/surface water bodies, from groundwater - Scenic areas/tourism areas/hill resorts - Religious places, pilgrim centers that attract over 10 lakh pilgrims a year - Protected tribal settlements (notified tribal areas where industrial activity is not permitted); CRZ - Monuments of national significance, World

		Heritage Sites - Cyclone, Tsunami prone areas (based on last 25 years); - Airport areas - Any other feature as specified by the State or local government and other features as locally applicable, including prime agricultural lands, pastures, migratory corridors, *etc*. ▪ If ecologically sensitive attributes fall within the study area, please give details. Ecologically sensitive attributes include - National parks - Wild life sanctuaries Game reserve - Tiger reserve/elephant reserve/turtle nesting ground - Mangrove area - Wetlands - Reserved and protected forests - Endangered species of flora and fauna - Any other eco-sensitive areas *etc*.
	Social aspects	▪ Corporate social responsibilities ▪ Employments and infrastructure added in the vicinity of the plant ▪ Status of land availability, current and post project land use variation ▪ Social sensitivity and likely project affected people, *etc*.
III.	**Anticipated impacts based on project operations on receiving environment**	▪ Population ▪ Flora and fauna ▪ Water ▪ Soil ▪ Air ▪ Climate ▪ Landscape, *etc.*
IV.	**Proposed broad mitigation measures which could effectively be internalized as project components to have environmental and social acceptance of the proposed site**	▪ Preventive measures ▪ Source control measures ▪ Mitigation measures at the receiving environment ▪ Health and safety measures of workers, *etc*.
V.	**An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the developer in compiling the required information.**	

The above listing is not exhaustive. Thus the proponent may provide additional necessary information, felt appropriate, to include in the pre-feasibility study report in support of selecting the site for the proposed developmental activities. The Concerned EAC/SEAC during scrutiny, may specifically ask for any additional information/data required to substantiate the requirement to prescribe the ToR for EIA studies. However, it is to make clear that all the required further information by EAC/SEAC may be mentioned in one single letter, within the prescribed time.

ANNEXURE X
Types of Monitoring and Network Design Considerations

TYPES OF MONITORING AND NETWORK DESIGN CONSIDERATIONS

A. Types of Monitoring

Monitoring refers to the collection of data using a series of repetitive measurements of environmental parameters (or, more generally, to a process of systematic observation). The environmental quality monitoring programme design will be dependent upon the monitoring objectives specified for the selected area of interest. The main types of EIA monitoring activities are:

- Baseline monitoring is the measurement of environmental parameters during the pre-project period for the purpose of determining the range of variation of the system and establishing reference points against which changes can be measured. This leads to the assessment of the possible (additional available) assimilative capacity of the environmental components in pre-project period w.r.t. the standard or target level.
- Effects monitoring is the measurement of environmental parameters during project construction and implementation to detect changes which are attributable to the project to provide the necessary information to:
  - verify the accuracy of EIA predictions; and
  - determine the effectiveness of measures to mitigate adverse effects of projects on the environment.
  - Feedback from environmental effect monitoring programs may be used to improve the predictive capability of EIAs and also determine whether more or less stringent mitigation measures are needed
- Compliance monitoring is the periodic sampling or continuous measurement of environmental parameters to ensure that regulatory requirements and standards are being met.

Compliance and effects monitoring occurs during the project construction, operation, and abandonment stages. The resources and institutional set-up should be available for the monitoring at these stages. All large-scale construction projects will require some construction stage monitoring. To control the environmental hazards of construction as specified in the EIA, a monitoring program should be established to ensure that each mitigation measure is effectively implemented. There are numerous potential areas for monitoring during operations.

The scope of monitoring topics discussed in this chapter is limited to Baseline and Effects monitoring. In addition, this chapter will also discuss the Compliance monitoring during the construction phase. Post-project monitoring requirements are discussed in the EMP.

Before any field monitoring tasks are undertaken there are many institutional, scientific, and fiscal issues that must be addressed in the implementation of an environmental monitoring program. Careful consideration of these issues in the design and planning stages will help avoid many of the pitfalls associated with environmental monitoring programs. Although these issues are important but the discussions here are confined to the monitoring network design component.

B. Network Design

Analysis of Significant Environmental Issues

At the outset of planning for an environmental monitoring network, the EIA manager may not know exactly what should be monitored, when monitoring should begin, where it should monitor, which techniques should be employed, and who should take responsibility for its conduct. Because there are usually a number of objective decisions associated with network design to be made, it is important to start with an analysis of environmental issues. The scoping phase of an EIA is designed to identify and focus on the major issues. Scoping should provide a valuable source of information on the concerns that need to be addressed by the monitoring network design. These are project specific as well as specific to the environmental setting of the location where the project is proposed to be located

Hence, the network designs are associated with questions like:

- What are the expected outputs of the monitoring activity?
- Which problems do we need to address to? *etc*.

Defining the output will influence the design of the network and optimize the resources used for monitoring. It will also ensure that the network is specially designed to optimize the information on the problems at hand

What to Monitor?

The question of what to monitor is associated with the identification of VECs.

VECs are generally defined as environmental attributes or components of the environment that are valued by society as identified during the scoping stage of the project. They are determined on the basis of perceived public concerns. For example, changes to water quality and quantity could have implications on fish by affecting habitat, food supply, oxygen, and contaminant uptake. Similarly, employment and business, and economies are both VECs that serve as pathways.

The choice of VECs is also related to the perceived significant impact of the project implementation on important environmental components. In general, the significance or importance of environmental components is judged based on:

- legal protection provided (for example, rare and endangered species)
- political or public concerns (for example, resource use conflicts and sustainable development)
- scientific judgment (for example, ecological importance); or
- commercial or economic importance

However, in addition to their economic, social, political or ecological significance, the chosen VEC should also have unambiguous operational ease, be accessible to prediction and measurement; and be susceptible to hazard. Once the VECs are defined, the VECs may be directly measured (for example, extent of habitat for an endangered species). In cases where it is impossible or impractical to directly measure the VECs, the chosen measurement endpoints or environmental indicators must correspond to, or be predictive of assessment endpoints.

The chosen environmental indicators must be: 1) measurable; 2) appropriate to the scale of disturbance/ contamination; 3) appropriate to the impact mechanism; 4) appropriate

and proportional to temporal dynamics; 5) diagnostic; and 6) standardized; as well as have: 1) a low natural variability; 2) a broad applicability; and 3) an existing data series.

Where, How and How Many Times to Monitor?

These are the other components of Monitoring Network Design. These questions are best answered based on local field conditions, capacity and resources available, prevailing legal and regulatory priorities, *etc*. For this screening or reconnaissance Surveys of the study area also necessary. This may also include some simple inexpensive measurements and assimilative/dispersion modeling. The data will give some information on the prevailing special and temporal variations, and the general background air pollution in the area. The number of monitoring stations and the indicators to be measured at each station in the final permanent network may then be decided upon based on the results of the screening study as well as on the knowledge of the sources of the proposed development and prevailing local environmental/meteorological conditions. The best possible definition of the air pollution problem, together with the analysis of the resources: personnel, budget and equipment available, represent the basis for the decision on the following questions:

- What spatial density (number) of sampling stations is required? How many samples are needed and during what period (sampling (averaging) time and frequency)?
- Where should the stations be located?
- What kind of equipment should be used?
- What additional background information is needed?
  - meteorology
  - topography
  - population density
  - emission sources and emission rates
  - effects and impacts
- How will the data be made available/communicated?

C. Site Selection

This normally means that for designing a monitoring programme in an (study) area which might have an impact, several monitoring stations are needed for characterizing the baseline conditions of the impacted area. When considering the location of individual samplers, it is essential that the data collected are representative for the location and type of area without the undue influence from the immediate surroundings. In any measurement point in the study area the total ambient concentration is the representative of:

- natural background concentration
- regional background
- impact of existing large regional sources such as Industrial emissions and other power plants

To obtain the information about the importance of these different contributions it is therefore necessary to locate monitoring stations so that they are representative for different impacts. In addition to the ambient pollution data, one would often need other data governing the variations such as meteorological data for air pollution, to identify and quantify the sources contributing to the measurements.. When considering the location of individual samplers, it is essential that the data collected are representative for the location and type of area without undue influence from the immediate surroundings.

ANNEXURE XI
Guidance for Assessment of Baseline Components and Attributes

GUIDANCE FOR ASSESSMENT OF BASELINE COMPONENTS AND ATTRIBUTES*

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
A. Air				
▪ Meteorological ▪ Wind speed ▪ Wind direction ▪ Dry bulb temperature ▪ Wet bulb temperature ▪ Relative humidity ▪ Rainfall ▪ Solar radiation ▪ Cloud cover	Minimum 1 site in the project impact area requirements Other additional site(s) are require depending upon the model applied or site sensitivities	Min: 1 hrly observations from continuous records	Mechanical / automatic weather station Rain gauge As per IMD As per IMD	IS 5182 Part 1-20 Sit-specific primary data is essential Secondary data from IMD, New Delhi for the nearest IMD station
Pollutants ▪ SPM ▪ RPM ▪ SO_2 ▪ NO_2 ▪ CO ▪ H_2S* ▪ HC* (parameters to be proposed by the proponent, in draft ToR, which will be reviewed and approved by EAC/SEAC)	10 to 15 locations in the project impact area	24 hrly twice a week 8 hrly twice a week 24 hrly twice a week	▪ Gravimetric (High – Volume) ▪ Gravimetric (High – Volume with Cyclone) ▪ EPA Modified West & Gaeke method ▪ Arsenite Modified Jacob & Hochheiser ▪ NDIR technique ▪ Methylene-blue ▪ Nessler's Method ▪ Infra Red analyzer ▪ Specific Ion meter	**Monitoring Network** ▪ Minimum 2 locations in upwind side, more sites in downwind side / impact zone ▪ All the sensitive receptors need to be covered **Measurement Methods** As per CPCB standards for NAQM, 1994

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
B. Noise				
Hourly equivalent noise levels	Same as for Air Pollution along with others Identified in study area	At lest one day continuous in each season on a working and non-working day	Instrument : Sensitive Noise level meter (preferably recording type)	Min: IS: 4954- 1968 as adopted by CPCB
Hourly equivalent noise levels	Inplant (1.5 m from machinery or high emission processes)	Same as above for day and night	Instrument : Noise level metre	CPCB / OSHA
Hourly equivalent noise levels	Highways (within 500 metres from the road edge)	Same as above for day and night	Instrument : Noise level meter	CPCB / IS : 4954-1968
C. Water				
Parameters for water quality ▪ Ph, temp, turbidity, magnesium hardness, total alkalinity, chloride, sulphate, nitrate, fluoride, sodium, potassium salinity ▪ Total nitrogen, total phosphorus, DO, BOD, COD, Phenol ▪ Heavy metals ▪ Total coliforms, faecal coliforms ▪ Phyto plankton ▪ Zooplankton ▪ Fish & other aquatic flora & fauna (parameters are given in ToR for EIA studies based on nature of project, raw material & process technology, location-nature/activities within of air basin)	Set of grab samples during pre and post- monsoon for ground and surface water for the whole study zone. For lab. Analysis the samples should be preserved for transport safe	Diurnal and season-wise	Samples for water quality should be collected and analyzed as per: IS: 2488 (Part 1-5) methods for sampling and testing of industrial effluents Standard methods for examination of water and waste water analysis published by American Public Health Association. International standard practices for benthos and aquatic flora & fauna	

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
For Surface Water Bodies				
▪ Total Carbon ▪ PH ▪ Dissolved Oxygen ▪ Biological Oxygen ▪ Demand ▪ Free NH_4 ▪ Boron ▪ Sodium Absorption ratio ▪ Electrical Conductivity	Monitoring locations should include up-stream, on site, down stream of proposed discharge point. Besides sampling should cover width of the river in case water quality modeling is proposed. Standard methodology for collection of surface water (BIS standards) At least one grab sample per location per season	Yield & impact on water sources to be measured during critical season River Stretch within project area be divided in grids (say 1 km length and 1/3 width) and samples should be from each grid at a time when the wastewater discharged by other sources of pollution is expected to be maximum	Samples for water quality should be collected and analyzed as per: IS: 2488 (Part 1-5) methods for sampling and testing of industrial effluents Standard methods for examination of water and wastewater analysis published by American Public Health Association.	Historical data should be collected from relevant offices such as central water commission, state and central ground water board, Irrigation dept.
Parameters for wastewater characterization				
▪ Temp, colour, odour, turbidity, TSS, TDS ▪ PH , alkalinity as CaCO3, p value, M value, tatal hardness as CaCO3, chloride as cl, sulphate as S04, Nitrate as NO3, Floride as F, Phosphate as P04, Chromium as Cr (Hexavalent, total) Ammonical Nitrogen as N, TKN, % sodium, BOD at 20 C, COD, DO, total residual chlorine as Cl2, oil and grease, sulphide, phenolic compound	Implant Source depending upon the different waste streams the parameters can be optimized Grab and composite sampling representing avg of different process operations as well as worst emission scenario should be represented	Different operational cycles as well as raw material variations should be reflected in the analysis	Samples for water quality should be collected and analyzed as per: IS: 2488 (Part 1-5) methods for sampling and testing of industrial effluents Standard methods for examination of water and wastewater analysis published by American Public Health Association.	All plant sources categorized as: ▪ Different Process waste streams as well as run-off conditions ▪ ETP wastewater Domestic/ sanitary wastewater
D. Land Environment				
▪ Soil	One surface sample from	Season-wise	Collected and analyzed as per soil	The purpose of impact

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
▪ Particle size distribution ▪ Texture ▪ pH ▪ Electrical conductivity ▪ Caution exchange capacity ▪ Alkali metals ▪ Sodium Absorption Ratio (SAR) ▪ Permeability ▪ Porosity	each landfill and/or hazardous waste site (if applicable) and prime villages, (soil samples be collected as per BIS specifications) in the study area		analysis reference book, M.I.Jackson and soil analysis reference book by C.A. Black	assessment on soil (land environment) is to assess the significant impacts due to leaching of wastes or accidental releases and contaminating
Landuse / Landscape				
▪ Location code ▪ Total project area ▪ Topography ▪ Drainage (natural) ▪ Cultivated, forest plantations, water bodies, roads and settlements	At least 20 points along with plant boundary and general major land use categories in the study area.	Drainage once in the study period and land use categories from secondary data (local maps) and satellite imageries	▪ Global positioning system ▪ Topo-sheets ▪ Satellite Imageries ▪ (1:25,000) ▪ Satellite Imageries ▪ (1:25,000)	Drainage within the plant area and surrounding is very important for storm water impacts. From land use maps sensitive receptors (forests, parks, mangroves etc.) can be identified
E. Solid Waste				
Quantity: ▪ Based on waste generated from per unit production ▪ Per capita contribution ▪ Collection, transport and disposal system ▪ Process Waste ▪ Quality (oily, chemical, biological)	For green field unites it is based on secondary data base of earlier plants.	Process wise or activity wise for respective raw material used. Domestic waste depends upon the season also	Guidelines IS 9569 : 1980 IS 10447 : 1983 IS 12625 : 1989 IS 12647 : 1989 IS 12662 (PTI) 1989	
Quality:	Grab and Composite	Process wise or activity wise for respective raw	Analysis	

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
▪ General segregation into biological/organic/inert/hazardous ▪ Loss on heating ▪ pH ▪ Electrical Conductivity ▪ Calorific value, metals etc.	samples	material used. Domestic waste depends upon the season also	IS 9334 : 1979 IS 9235 : 1979 IS 10158 : 1982	
Hazardous Waste				
▪ Permeability And porosity ▪ Moisture pH ▪ Electrical conductivity ▪ Loss on ignition ▪ Phosphorous ▪ Total nitrogen ▪ Caution exchange capacity ▪ Particle size distribution ▪ Heavy metal ▪ Ansonia ▪ Fluoride	Grab and Composite samples. Recyclable components have to analyzed for the recycling requirements	Process wise or activity wise for respective raw material used.	Analysis IS 9334 : 1979 IS 9235 : 1979 IS 10158 : 1982	Impacts of hazardous waste should be performed critically depending on the waste characteristics and place of discharge. For land disposal the guidelines should be followed and impacts of accidental releases should be assessed
F. Biological Environment Aquatic				
▪ Primary productivity ▪ Aquatic weeds ▪ Enumeration of ▪ phytoplankton, zooplankton and benthos ▪ Fisheries ▪ Diversity indices ▪ Trophic levels ▪ Rare and endangered species ▪ Sanctuaries / closed areas /	Considering probable impact, sampling points and number of samples to be decided on established guidelines on ecological studies based on site eco-environment setting within 10/25 km radius from the proposed site Samples to collect from	Season changes are very important	Standards techniques (APHA et. Al. 1995, Rau and Wooten 1980) to be followed for sampling and measurement	Seasonal sampling for aquatic biota One season for terrestrial biota, in addition to vegetation studies during monsoon season Preliminary assessment Microscopic analysis of plankton and meiobenthos, studies of macrofauna, aquatic

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
Coastal regulation zone (CRZ) ▪ Terrestrial ▪ Vegetation – species, list, economic importance, forest produce, medicinal value ▪ Importance value index (IVI) of trees ▪ Wild animals	upstream and downstream of discharge point, nearby tributaries at down stream, and also from dug wells close to activity site			vegetation and application of indices, viz. Shannon, similarity, dominance IVI etc Point quarter plot-less method (random sampling) for terrestrial vegetation survey.
Avifauna ▪ Rare and endangered species ▪ Sanctuaries / National park / Biosphere reserve	For forest studies, chronic as well as short-term impacts should be analyzed warranting data on micro climate conditions			Secondary data to collect from Government offices, NGOs, published literature Plankton net Sediment dredge Depth sampler Microscope Field binocular
G. Socio Economic				
▪ Demographic structure ▪ Infrastructure resource base ▪ Economic resource base ▪ Health status: Morbidity pattern ▪ Cultural and aesthetic attributes	Socio-economic survey is based on proportionate, stratified and random sampling method	Different impacts occurs during construction and operational phases of the project	Primary data collection through R&R surveys (if require) or community survey are based on personal interviews and questionnaire	Secondary data from census records, statistical hard books, toposheets, health records and relevant official records available with Govt. agencies

* Project Specific concerned parameters needs to be identified by the project proponent and shall be incorporated in the draft ToR, to be submitted to the Authority for the consideration and approval by the EAC/SEAC

ANNEXURE XII
Sources of Secondary Data

Annexure XIIA: Potential Sources of Data For EIA

	Information	Source
	Air Environment	
1.	Meteorology- Temperature, Rainfall, Humidity, Inversion, Seasonal Wind rose pattern (16 point compass scale), cloud cover, wind speed, wind direction, stability, mixing depth	⑨ Indian Meteorology Department, Pune
2.	Ambient Air Quality- 24 hourly concentration of SPM, RPM, SO_2, NO_x, CO	⑨ Central Pollution Control Board (CPCB), ⑨ State Pollution Control Board (SPCB), ⑨ Municipal Corporations ⑨ Ministry of Environment and Forests (MoEF) ⑨ State Department of Environment (DoEN)
	Water Environment	
3.	Surface water- water sources, water flow (lean season), water quality, water usage, Downstream water users Command area development plan Catchment treatment plan	⑨ Central Water Commission (CWC), ⑨ Central Pollution Control Board (CPCB), ⑨ State Pollution Control Board (SPCB), Central Water and Power Research Institute (CWPRS), Pune ⑨ State Irrigation Department ⑨ Hydel Power generation organizations such as NHPC, State SEBs
4.	Ground Water- groundwater recharge rate/withdrawal rate, ground water potential groundwater levels (pre monsoon, post monsoon), ground water quality, changes observed in quality and quantity of ground water in last 15 years	⑨ Central Ground Water Board (CGWB) ⑨ Central Ground Water Authority (CGWA) ⑨ State Ground Water Board (SGWB) ⑨ National Water Development Authority (NWDA)
5.	Coastal waters- water quality, tide and current data, bathymetry	⑨ Department of Ocean Development, New Delhi ⑨ State Maritime Boards ⑨ Naval Hydrographer's Office, Dehradun ⑨ Port Authorities ⑨ National Institute of Oceanography (NIO), Goa
	Biological Environment	
6.	Description of Biological Environment- inventory of flora and fauna in 7 km radius, endemic species, endangered species, Aquatic Fauna, Forest land, forest type and density of vegetation, biosphere, national parks, wild life sanctuaries, tiger reserve, elephant reserve, turtle nesting ground, core zone of biosphere reserve, habitat of migratory birds, routes of migratory birds	⑨ District Gazetteers ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ Forest Survey of India, Dehradun ⑨ Wildlife Institute of India ⑨ World Wildlife Fund ⑨ Zoological Survey of India ⑨ Botanical Survey of India ⑨ Bombay Natural History Society, (BNHS), Mumbai ⑨ State Forest Departments ⑨ State Fisheries Department ⑨ Ministry of Environment and Forests ⑨ State Agriculture Departments ⑨ State Agriculture Universities
	Land Environment	
7.	Geographical Information-Latitude, Longitude, Elevation (above MSL)	⑨ Toposheets of Survey of India, Pune ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ Space Application Centre (SAC), Ahmedabad

	Information	Source
8.	Nature of Terrain, topography map indicating contours (1:2500 scale)	⑨ Survey of India Toposheets ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ State Remote Sensing Centre, ⑨ Space Application Centre (SAC), Ahmedabad
9.	Hydrogeology- Hydrogeological report (in case of ground water is used/area is drought prone/wastewater is likely to discharged on land) Geomorphological analysis (topography and drainage pattern) Geological analysis (Geological Formations/Disturbances- geological and structural maps, geomorphological contour maps, structural features, including lineaments, fractures, faults and joints) Hydrogeological analysis (disposition of permeable formations, surface-ground water links, hydraulic parameter determination etc) Analysis of the natural soil and water to assess pollutant absorption capacity	⑨ NRSA, Hyderbad ⑨ Survey of India Toposheets ⑨ Geological Survey of India ⑨ State Geology Departments ⑨ State Irrigation Department ⑨ Department of Wasteland Development, Ministry of Rural Areas ⑨ National Water Development Authority (NWDA)
10.	Nature of Soil, permeability, erodibility classification of the land	⑨ Agriculture Universities ⑨ State Agriculture Department ⑨ Indian Council for Agriculture Research ⑨ State Soil Conservation Departments ⑨ National Bureau of Soil Survey and Landuse Planning ⑨ Central Arid Zone Research Institute (CAZRI), Jodhpur
11.	Landuse in the project area and 10 km radius of the periphery of the project	⑨ Survey of India- Toposheets ⑨ All India Soil and Landuse Survey; Delhi ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ Town and County Planning Organisation ⑨ State Urban Planning Department ⑨ Regional Planning Authorities (existing and proposed plans) ⑨ Village Revenue Map- District Collectorate ⑨ Directorate of Economics and Statistics-State Government ⑨ Space Application Centre, Ahmedabad
12.	Coastal Regulation Zones- CRZMP, CRZ classification, Demarcation of HTL and LTL*	⑨ Urban Development Department ⑨ State Department of Environment ⑨ State Pollution Control Board ⑨ Space Application Centre* ⑨ Centre for Earth Sciences Studies, Thiruvanthapuram* ⑨ Institute of Remote Sensing, Anna University Chennai* ⑨ Naval Hydrographer's Office, Dehradun* ⑨ National Institute of Oceanography, Goa* ⑨ National Institute of Ocean Technology, Chennai ⑨ Centre for Earth Science Studies

* *Agencies authorized for approval of demarcation of HTL and LTL*

	Information	Source
	Social	
13.	Socioeconomic - population, number of houses and present occupation pattern within 7 km from the periphery of the project	⑨ Census Department ⑨ District Gazetteers- State Government ⑨ District Statistics- District Collectorate ⑨ International Institute of Population Sciences, Mumbai (limited data) ⑨ Central Statistical Organisation
14.	Monuments and heritage sites	District Gazetteer Archeological Survey of India, INTACH District Collectorate Central and State Tourism Department State Tribal and Social Welfare Department
	Natural Disasters	
15.	Seismic data (Mining Projects)- zone no, no of earthquakes and scale, impacts on life, property existing mines	⑨ Indian Meteorology Department, Pune ⑨ Geological Survey of India
16.	Landslide prone zone, geomorphological conditions, degree of susceptibility to mass movement, major landslide history (frequency of occurrence/decade), area affected, population affected	⑨ Space Application Centre
17.	Flood/cyclone/droughts- frequency of occurrence per decade, area affected, population affected	⑨ Natural Disaster Management Division in Department of Agriculture and Cooperation ⑨ Indian Meteorological Department
	Industrial	
18.	Industrial Estates/Clusters, Growth Centres	⑨ State Industrial Corporation ⑨ Industrial Associations ⑨ State Pollution Control Boards ⑨ Confederation Indian Industries (CII) ⑨ FICCI
19.	Physical and Chemical properties of raw material and chemicals (Industrial projects); fuel quality	⑨ Material and Safety Data Sheets ⑨ ENVIS database of Industrial Toxicological Research Centre, Lucknow ⑨ Indian Institute Petroleum
20.	Occupational Health and Industrial Hygiene- major occupational health and safety hazards, health and safety requirements, accident histories	⑨ Central Labour Institute, Mumbai ⑨ Directorate of Industrial Safety ⑨ ENVIS Database of Industrial Toxicological Research Centre, Lucknow ⑨ National Institute of Occupational Health, Ahmedabad
21.	Pollutant release inventories (Existing pollution sources in area within 10 km radius)	⑨ Project proponents which have received EC and have commenced operations
22.	Water requirement (process, cooling water, DM water, Dust suppression, drinking, green belt, fire service)	⑨ EIA Reports ⑨ National and International Benchmarks

Annexure XIIB: Summary of Available Data with Potential Data Sources for EIA

	Agency	Information Available
1.	Archaeological Survey of India Department of Culture Government of India Janpath, New Delhi - 110011 Asi@del3.vsnl.net.in	⑨ Inventory of monuments and sites of national importance- Listing and documentation of monuments according to world heritage, pre historic, proto historic and secular, religious places and forts
2.	Botanical Survey Of India P-8, Brabourne Road Calcutta 700001 Tel#033 2424922 Fax#033 2429330 Email: envis@cal2.vsnl.net.in. . RO - Coimbatore, Pune, Jodhpur, Dehradun, Allahabad, Gantok, Itanagar, Port Blair	⑨ Photodiversity documentation of flora at National, State and District level and flora of protected areas, hotspots, fragile ecosystems, sacred groves etc ⑨ Identification of threatened species including endemics, their mapping, population studies ⑨ Database related to medicinal plants, rare and threatened plant species ⑨ Red data book of Indian plants (Vol 1,2, and 3) ⑨ Manual for roadside and avenue plantation in India
3.	Bureau of Indian Standards Manak Bhawan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002 Tel#3230131, 3233375, 3239402 (10 lines) Fax : 91 11 3234062, 3239399, 3239382 Email- bis@vsnal.com	⑨ Bureau of Indian Standards Committees on Earthquake Engineering and Wind Engineering have a Seismic Zoning Map and the Wind Velocity Map including cyclonic winds for the country
4.	Central Water Commission (CWC) Sewa Bhawan, R.K.Puram New Delhi - 110066 cmanoff@niccwc.delhi.nic.in RO- Bangalore, Bhopal, Bhubaneshwar, Chandigarh, Coimbatore/Chennai, Delhi, Hyderabad, Lucknow, Nagpur, Patna, Shillong, Siliguri and Vadodara	⑨ Central Data Bank -Collection, collation and Publishing of Hydrological, Hydrometeorological, Sediment and Water Quality data-. ⑨ Basin wise Master Plans ⑨ Flood atlas for India ⑨ Flood Management and Development and Operation of Flood Forecasting System- CWC operate a network of forecasting stations Over 6000 forecasts are issued every year with about 95% of the forecasts within the permissible limit. ⑨ Water Year Books, Sediment Year Books and Water Quality Year Books. ⑨ Also actively involved in monitoring of 84 identified projects through National, State and Project level Environmental Committees for ensuring implementation of environmental safeguards
5.	Central Ground Water Board (HO) N.H.IV, New CGO Complex, Faridabad - 121001 RO - Guwahati, Chandigarh, Ahemadabad, Trivandrum, Calcutta, Bhopal, Lucknow, Banglore, Nagpur, Jammu, Bhubneshwar, Raipur, Jaipur, Chennai, Hyderabad, Patna	⑨ surveys, exploration, monitoring of ground water development

[16] *Based on web search and literature review*

6.	Central Pollution Control Board Parivesh Bhawan, CBD-cum-Office Complex East Arjun Nagar, DELHI - 110 032 INDIA E-mail : cpcb@alpha.nic.in	⑨ National Air Quality Monitoring Programme ⑨ National River Water Quality Monitoring Programme- Global Environment Monitoring , MINARS ⑨ Zoning Atlas Programme ⑨ Information on 17 polluting category industries (inventory, category wise distribution, compliance, implementation of pollution control programmes
7.	Central Arid Zone Research Institute, Jodhpur Email : cazri@x400.nicgw.nic.in Regional Centre at Bhuj in Gujarat	⑨ AGRIS database on all aspects of agriculture from 1975 to date ⑨ Also have cell on Agriculture Research Information System; ⑨ Working on ENVIS project on desertification ⑨ Repository of information on the state of natural resources and desertification processes and their control ⑨ The spectrum of activities involves researches on basic resource inventories; monitoring of desertification, rehabilitation and management of degraded lands and other areas
8.	Central Inland Capture Fisheries Research Institute, Barrackpore-743101, Tel#033-5600177 Fax#033-5600388 Email : cicfri@x400.nicgw.nic.in	⑨ Data Base on Ecology and fisheries of major river systems of India. Biological features of commercially important riverine and estuarine fish species. Production functions and their interactions in floodplain wetlands. ⑨ Activities - Environmental Impact Assessment for Resource Management ; Fisheries Resource surveys
9.	Central Institute of Brackish Water Aquaculture 141, Marshalls Road, Egmore , Chennai - 600 008, Tel# 044-8554866, 8554891, Director (Per) 8554851 Fax#8554851,	⑨ Repository of information on brackish water fishery resources with systematic database of coastal fishery resources for ARIS ⑨ Agricultural Research Information System (ARIS) database covers State wise data on soil and water quality parameters, land use pattern, production and productivity trends, ⑨ Social, economic and environmental impacts of aquaculture farming, ⑨ Guidelines and effluent standards for aquaculture farming
10.	Central Marine Fisheries Research Institute (CMFRI), Cochin	⑨ Assessing and monitoring of exploited and un-exploited fish stocks in Indian EEZ ⑨ Monitoring the health of the coastal ecosystems, particularly the endangered ecosystems in relation to artisanal fishing, mechanised fishing and marine pollution ⑨ The institute has been collecting data on the catch and effort and biological characteristics for nearly half a century based on scientifically developed sampling scheme, covering all the maritime States of the country ⑨ The voluminous data available with the institute is managed by the National Marine Living Resources Data Centre (NMLRDC)
11.	Central Water and Power Research Station, Pune Tel#020-4391801-14; 4392511; 4392825 Fax #020-4392004,4390189	⑨ Numerical and Physical models for hydro-dynamic simulations
12.	Central Institute of Road Transport, Bhosari, Pune 411 026, India. Tel : +91 (20) 7125177, 7125292, 7125493, 7125494	⑨ Repository of data on all aspects of performance of STUs and a host of other related road transport parameters

13.	Department of Ocean Development	⑨ Assessment of environment parameters and marine living resources (primary and secondary) in Indian EEZ (Nodal Agency NIO Kochi) ⑨ Stock assessment, biology and resource mapping of deep sea shrimps, lobsters and fishes in Indian EEZ (Nodal agency-Fisheries Survey of India) ⑨ Investigations of toxical algal blooms and benthic productivity in Indian EEZ (Nodal agency- Cochin University of Science and technology) ⑨ Coastal Ocean Monitoring and Prediction System (COMAP) - monitoring and modelling of marine pollution along entire Indian coast and islands. Parameters monitored are temp, salinity, DO, pH, SS, BOD, inorganic phosphate, nitrate, nitrite, ammonia, total phosphorus, total nitrite, total organic carbon, petroleum hydrocarbons, pathogenic vibros, pathogenic E.coli, shigella, salmonella, heavy metals (Cd, Hg, Pb) and pesticide residues (DDT, BHC, Endosulfan). Monitoring is carried out along the ecologically sensitive zones and urban areas (NIO Mumbai- Apex coordinating agency). ⑨ Sea Level Measurement Programe (SELMAM)- sea level measurement at selected stations (Porbandar, Bombay, Goa, Cochin, Tuticorin, Madras, Machilipatnam, Visakhapatnam, Paradeep, Calcutta and Kavaratti (Lakshadweep Island)) along Indian coast and islands using modern tide gauges ⑨ Detailed coastal maps through Survey of India showing contour at 1/2 a metre interval in the scale of 1:25000. (Nellore- Machhalipatnam work already over) ⑨ Marine Data Centre (MDC) IMD for Ocean surface meteorology, GSI for marine geology, SOI for tide levels, Naval Hydrographic Office for bathymetry, NIO Goa for physical chemical and biological oceanography, NIO Mumbai for marine pollution, CMFRI for coastal fisheries, Institute of Ocean Management Madras for coastal geomorphology ⑨ DOD has setup Indian National Centre for Ocean Information Services (INCOIS) at Hyderabad for generation and dissemination of ocean data products (near real time data products such as sea surface temperature, potential fishing zones, upwelling zones, maps, eddies, chlorophyll, suspended sediment load etc). MDC will be integrated with INCOIS ⑨ Integrated Coastal and Marine Area Management (ICMAM) programme - GIS based information system for management of 11 critical habitats namely Pichavaram, Karwar, Gulf of Mannar, Gulf of Khambat, Gulf of Kutch, Malvan, Cochin, Coringa mangroves, Gahirmata, Sunderbans and Kadamat (Lakshadeep) ⑨ Wetland maps for Tamil Nadu and Kerala showing the locations of lagoons, backwaters, estuaries, mudflats etc (1:50000 scale) ⑨ Coral Reef Maps for Gulf of Kachch, Gulf of Mannar, Andaman and Nicobar and Lakshadeep Islands (1:50,000 scale) indicating the condition of corals, density etc
14.	Environment Protection Training and Research Institute Gachibowli, Hyderabad - 500 019, India Phone: +91-40-3001241, 3001242, 3000489 Fax: +91-40- 3000361 E-mail: info@eptri.com	⑨ Environment Information Centre- has appointed EPTRI as the Distributed Information Centre for the Eastern Ghats region of India. EIC Collaborates with the Stockholm Environment Institute Sweden Database on Economics of Industrial Pollution Prevention in India Database of Large and Medium Scale Industries of Andhra Pradesh Environmental Status of the Hyderabad Urban Agglomeration Study on 'water pollution-health linkages' for a few Districts of A.P

		⑨ Environment Quality Mapping Macro level studies for six districts in the State of Andhra Pradesh Micro level studies for two study zones presenting the permissible pollutant load and scoping for new industrial categories Zonation of the IDA, Parwada which helped APIIC to promote the land for industrial development Disaster management plan for Visakhapatnam Industrial Bowl Area
15.	Forest Survey of India (FSI) Kaulagarh Road, P.O., IPE Dehradun - 248 195 Tel# 0135-756139, 755037, 754507 Fax # 91-135-759104 E-Mail : fsidir@nde.vsnl.net.in fsihq@nde.vsnl.net.in RO- Banglore, Calcutta, Nagpur and Shimla	⑨ State of Forest Report (Biannual) ⑨ National Forest Vegetation Map (Biannual exercise) (on 1: 1 million scale) ⑨ Thematic mapping on 1:50,000 scale depicting the forest type, species composition, crown density of forest cover and other landuse National ⑨ Basic Forest Inventory System ⑨ Inventory survey of non forest area ⑨ Forest inventory report providing details of area estimates, topographic description, health of forest, ownership pattern, estimation of volume and other growth parameters such as height and diameter in different types of forest, estimation of growth, regeneration and mortality of important species, volume equation and wood consumption of the area studied
16.	Geological Survey of India 27 Jawaharlal Nehru Road, Calcutta 700 016, India Telephone +91-33-2496941 FAX 91-33-2496956 gsi_chq@vsnl.com	⑨ Environmental hazards zonation mapping in mineral sector ⑨ Codification of base line information of geo-environmental appreciation of any terrain and related EIA and EMP studies ⑨ Lineament and geomorphological map of India on 1:20,000 scale. ⑨ Photo-interpreted geological and structural maps of terrains with limited field checks.
17.	Indian Council of Agriculture Research, Krishi Bhawan, New Delhi, Tel#011-338206 – ICAR complex, Goa- Agro metrology – Central Arid Zone Research Institute- Agro forestry – Central Soil salinity Research Institute, – Indian Institute of Soil Science – Central Soil and Water Conservation Research and Training Institute – National Bureau of Soil Survey and Landuse Planning	⑨ A total of 80,000 profiles at 10 kms grid across the country were analyzed to characterize the soils of India. ⑨ Detailed soil maps of the Country (1:7 million), State (1:250,000) and districts map (1:50,000) depicting extent of degradation (1:4.4 millions) have been prepared. ⑨ Thematic maps depicting soil depth, texture drainage, calcareousness, salinity, pH, slope and erosion have been published ⑨ Agro-climate characterization of the country based on moisture, thermal and sunshine regimes ⑨ Agro-ecological zones (20) and sub-zones (60) for the country were delineated based on physiography, soils, climate, Length of Growing Period and Available Water Content, and mapped on 1:4.4 million scale. ⑨ Digitization of physiography and soil resource base on 1:50,000 scale for 14 States have been completed. ⑨ .Soil fertility maps of N,P,K,S and Zn have also been developed ⑨ Water quality guidelines for irrigation and naturally occurring saline/sodic water ⑨ Calibration and verification of ground water models for predicting water logging and salinity hazards in irrigation commands
18.	Indian Bureau of Mines Indira Bhawan, Civil Lines Nagpur Ph no - 0712-533 631, Fax- 0712-533 041	⑨ National mineral inventory for 61 minerals and mineral maps ⑨ Studies on environmental protection and pollution control in regard to the mining and mineral beneficiation operations ⑨ Collection, processing and storage of data on mines, minerals and mineral-based industries, collection and maintenance of world mineral intelligence, foreign mineral legislation and other related matters

19.	Indian Meteorology Department Shivaji nagar, Pune 41100 RO- Mumbai, Chennai, Calcutta, New Delhi, Nagpur, Guwahati	⑨ Meteorological data ⑨ Background air quality monitoring network under Global Atmospheric Watch Programme (operates 10 stations) ⑨ Seismicity map, seismic zoning map; seismic occurrences and cyclone hazard monitoring; list of major earthquakes ⑨ Climatological Atlas of India , Rainfall Atlas of India and Agroclimatic Atlas of India ⑨ Monthly bulletin of Climate Diagnostic Bulletin of India ⑨ Environmental Meteorological Unit of IMD at Delhi to provide specific services to MoEF
20.	INTACH Natural Heritage, 71 Lodi Estate, New Delhi-110 003 Tel. 91-11-4645482, 4632267/9, 4631818, 4692774, 4641304 Fax : 91-11-4611290 E-mail : nh@intach.net	⑨ Listing and documentation of heritage sites identified by municipalities and local bodies (Listing excludes sites and buildings under the purview of the Archaeological Survey of India and the State Departments of Archaeology)
21.	Industrial Toxicology Research Centre Post Box No. 80, Mahatma Gandhi Marg, Lucknow-226001, Phone: +91-522-221856,213618,228227; Fax : +91-522 228227 Email: itrc@itrcindia.org	⑨ Activities include health survey on occupational diseases in industrial workers, air and water quality monitoring studies, ecotoxicological impact assessment, toxicity of chemicals, human health risk assessment ⑨ Five databases on CD-ROM in the area of environmental toxicology viz: TOXLINE, CHEMBANK, POISINDEX, POLTOX and PESTBANK. The Toxicology Information Centre provides information on toxic chemicals including household chemicals ⑨ ENVIS centre and created a full-fledged computerized database (DABTOC) on toxicity profiles of about 450 chemicals
22.	Indian Institute of Forest Management Post Box No. 357, Nehru Nagar Bhopal - 462 003 Phone # 0755-575716, 573799, 765125, 767851 Fax # 0755-572878	⑨ Consultancy and research on joint forest management (Ford Foundation, SIDA, GTZ, FAO etc)
23.	Indian Institute of Petroleum Mohkampur , Dehradun, India, 248005 0135- 660113 to 116 0135- 671986	⑨ Fuel quality characterisation ⑨ Emission factors
24.	Ministry of Environment and Forest	⑨ Survey of natural resources ⑨ National river conservation directorate ⑨ Environmental research programme for eastern and western ghats ⑨ National natural resource management system ⑨ Wetlands conservation programme- survey, demarcation, mapping landscape planning, hydrology for 20 identified wetlands National ⑨ wasteland identification programme
25.	Mumbai Metropolitan Regional Development Authority	⑨ Mumbai Urban Transport Project ⑨ Mumbai Urban Development Project ⑨ Mumbai Urban Rehabilitation Project ⑨ Information on MMR; statistics on councils and corporations Regional ⑨ Information Centre- Basic data on population, employment, industries and other sectors are regularly collected and processed

26.	Municipal Corporation of Greater Mumbai	⑨ Air Quality Data for Mumbai Municipal Area ⑨ Water quality of lakes used for water supply to Mumbai
27.	Ministry of Urban Development Disaster Mitigation and Vulnerability Atlas of India Building Materials & Technology Promotion Council G-Wing,Nirman Bhavan, New Delhi-110011 Tel: 91-11-3019367 Fax: 91-11-3010145 E-Mail: bmtpc@del2.vsnl.net.in	⑨ Identification of hazard prone area ⑨ Vulnerability Atlas showing areas vulnerable to natural disasters ⑨ Land-use zoning and design guidelines for improving hazard resistant construction of buildings and housing ⑨ State wise hazard maps (on cyclone, floods and earthquakes)
28.	Natural Disaster Management Division in Department of Agriculture and Cooperation	⑨ Weekly situation reports on recent disasters, reports on droughts, floods, cyclones and earthquakes
29.	National Bureau Of Soil Survey & Land Use Planning P.O. Box No. 426, Shankar Nagar P.O., Nagpur-440010 Tel#91-712-534664,532438,534545 Fax#:91-712-522534 RO- Nagpur, New Delhi, Banglore, Calcutta, Jorhat, Udaipur	⑨ NBSS&LUP Library has been identified as sub centre of ARIC (ICAR) for input to AGRIS covering soil science literature generated in India ⑨ Research in weathering and soil formation, soil morphology, soil mineralogy, physicochemical characterisation, pedogenesis, and landscape-climate-soil relationship. ⑨ Soil Series of India- The soils are classified as per Soil Taxonomy. The described soil series now belong to 17 States of the country. ⑨ Landuse planning- watershed management, land evaluation criteria, crop efficiency zoning ⑨ Soil Information system is developed state-wise at 1:250,000 scale. Presently the soil maps of all the States are digitized, processed and designed for final output both digital and hardcopy. The thematic layers and interpreted layers of land evaluation (land capability, land irrigability and crop suitability), Agro-Ecological Zones and soil degradation themes are prepared. ⑨ Districts level information system is developed for about 15 districts at 1: 50, 000 scale. The soil information will be at soil series level in this system. Soil resource inventory of States, districts water-sheds (1:250,000; 1:50,000; 1:10,000/8000)
30.	National Institute of Ocean Technology, Velacherry-Tambaram main road Narayanapuram Chennai, Tamil Nadu Tel#91-44-2460063 / 2460064/ 2460066/ 2460067 Fax#91-44-2460645	⑨ Waste load allocation in selected estuaries (Tapi estuary and Ennore creek) is one the components under the Integrated Coastal and Marine Area Management (ICMAM) programme of the Department of Ocean Development ICMAM is conducted with an IDA based credit to the Government of India under the Environmental Capacity Building project of MoEF (waste assimilation capacity of Ennore creek is over) ⑨ Physical oceanographic component of Coastal & Ocean monitoring Predictive System (COMAPS) a long term monitoring program under the Department of Ocean Development ⑨ Identification of suitable locations for disposal of dredge spoil using mathematical models & environmental criteria ⑨ EIA Manual and EIA guidelines for port and harbour projects
31.	National Institute of Oceanography, Goa RO- Mumbai, Kochi	⑨ Coastal Ocean Monitoring and Predictions(COMAP)-Monitoring of coastal waters for physicochemical and biological parameters including petroleum hydrocarbons, trace metals, heavy metals, and biomass of primary (phytoplankton) and secondary (zooplankton, microbial and benthic organisms) ⑨ Marine Biodiversity of selected ecosystem along the West Coast of India

32.	National Botanical Research Institute, Post Box No 436 Rana Pratap Marg Lucknow- 226001, Tel: (+91) 522 271031-35 Fax: (+91) 522 282849, 282881 Lucknow	⑨ Dust filtering potential of common avenue trees and roadside shrubs has been determined, besides studies have also been conducted on heavy-metals accumulation potential of aquatic plants supposedly useful as indicators of heavy metal pollution in water bodies and capable of reducing the toxic metals from water bodies. ⑨ Assessment of bio-diversity of various regions of India
33.	National Geophysical Research Institute, Uppal Road, Hyderabad Telephone:0091-40-7171124, FAX:0091-40-7171564	⑨ Exploration, assessment and management of ground water resources including ground water modelling and pollution studies
34.	National Environmental Engineering Research Institute, Nagpur RO- Mumbai, Delhi, Chennai, Calcutta, Ahmedabad, Cochin, Hyderabad, Kanpur	⑨ National Air Quality Monitoring (NAQM) for CPCB ⑨ Database on cleaner technologies of industrial productions
35.	National Hydrology Institute, Roorkee RO- Belgaum (Hard Rock Regional Centre), Jammu (Western Himalayan Regional Centre), Guwahati (North Eastern Regional Centre), Kakinada (Deltaic Regional Centre), Patna (Ganga Plains North Regional Centre), and Sagar (Ganga Plains South)	⑨ Basin studies, hydrometeorological network improvement, hydrological year book, hydrological modelling, regional flood formulae, reservoir sedimentation studies, environmental hydrology, watershed development studies, tank studies, and drought studies.
36.	National Institute Of Urban Affairs, India Habitat Centre, New Delhi	⑨ Urban Statistics Handbook
37.	National Institute of Occupational Health Meghaninagar, Ahmedabad RO- Banglore, Calcutta	⑨ epidemiological studies and surveillance of hazardous occupations including air pollution, noise pollution, agricultural hazards, industrial hazards in organised sectors as well as small scale industries, carcinogenesis, pesticide toxicology, etc ⑨ WHO collaborative centre for occupational health for South East Asia region and the lead institute for the international programme on chemical safety under IPCS (WHO)
38.	NRSA Data Centre Department of Space, Balanagar, Hyderabad 500 037 Ph- 040-3078560 3078664 sales@nrsa.gov.in	⑨ Satellite data products (raw data, partially processed (radiometrically corrected but geometrically uncorrected), standard data (radiometrically and geometrically corrected), geocoded data(1:50,000 and 1:25000 scale), special data products like mosaiced, merged and extracted) available on photographic (B?W and FCC in form of film of 240 mm X 240mm or enlargements/paper prints in scale varying between 1:1M and 1:12500 and size varying between 240mm and 1000mm) and digital media (CD-ROMs, 8 mm tapes)
39.	Rajiv Gandhi National Drinking Water Mission	⑨ Database for groundwater using remote sensing technology (Regional Remote Sensing Service Centre involved in generation of ground water prospect maps at 1:50,000 scale for the State of Kerala, Karnataka, AP, MP and Rajasthan for RGNDWM)
40.	Space Application Centre Value Added Services Cell (VASC) Remote Sensing Application Area Ahmedabad 380 053 079-676 1188	⑨ National Natural Resource Information System ⑨ Landuse mapping for coastal regulation zone (construction setback line) upto 1:12500 scale ⑨ Inventory of coastal wetlands, coral reefs, mangroves, seaweeds ⑨ Monitoring and condition assessment of protected coastal areas

	Fax- 079-6762735	⑨ Wetland mapping and inventory ⑨ Mapping of potential hotspots and zoning of environmental hazards ⑨ General geological and geomorphological mapping in diverse terrain ⑨ Landslide risk zonation for Tehre area
41.	State Pollution Control Board	⑨ State Air Quality Monitoring Programme ⑨ Inventory of polluting industries ⑨ Identification and authorization of hazardous waste generating industries ⑨ Inventory of biomedical waste generating industries ⑨ Water quality monitoring of water bodies receiving wastewater discharges ⑨ Inventory of air polluting industries ⑨ Industrial air pollution monitoring ⑨ Air consent, water consent, authorization, environment monitoring reports
42.	State Ground Water Board	
43.	Survey of India	⑨ Topographical surveys on 1:250,000 scales, 1:50,000 and 1:25,000 scales ⑨ Digital Cartographical Data Base of topographical maps on scales 1:250,000 and 1:50,000 ⑨ Data generation and its processing for redefinition of Indian Geodetic Datum ⑨ Maintenance of National Tidal Data Centre and receiving/ processing of tidal data of various ports. ⑨ Coastal mapping along the Eastern coast line has been in progress to study the effect of submergence due to rise in sea-level and other natural phenomenon. Ground surveys have been completed for the proposed coastal region and maps are under printing. ⑨ District planning maps containing thematic information (135 maps) have been printed out of 249 maps covering half the districts of India. Districts planning maps for remaining half of the area are being processed by National Atlas and Thematic Mapping Organisation (NATMO)
44.	Town and Country Planning Organisation	⑨ Urban mapping - Thematic maps and graphic database on towns (under progress in association with NRSA and State town planning department)
45.	Wildlife Institute of India Post Bag No. 18, Chandrabani Dehradun - 248 001, Uttaranchal Tel#0135 640111 -15, Fax#0135 640117 email : wii@wii .	⑨ Provide information and advice on specific wildlife management problems. ⑨ National Wildlife Database
46.	Zoological Survey of India Prani Vigyan Bhawan 'M' Block, New Alipore Calcutta - 700 053 Phone # 91-33-4786893, 4783383 Fax # 91-33-786893 RO - Shillong, Pune, Dehradun, Jabalpur, Jodhpur, Chennai, Patna, Hyderabad, Canning, Behrampur, Kozikode, Itanagar, Digha, Port Bliar, Solan	⑨ Red Book for listing of endemic species ⑨ Survey of faunal resources

ANNEXURE XIII
Impact Prediction Tools

Table 1: Choice of Models for Impact Prediction: Air Environment*

Model	Application	Remarks
ISCST 3	▪ Appropriate for point, area and line sources ▪ Application for flat or rolling terrain ▪ Transport distance up to 50 km valid ▪ Computes for 1 hr to annual averaging periods	▪ Can take up to 99 sources ▪ Computes concentration on 600 receptors in Cartesian on polar coordinate system ▪ Can take receptor elevation ▪ Requires source data, meteorological and receptor data as input.
AERMOD with AERMET	▪ Settling and dry deposition of particles; ▪ Building wake effects (excluding cavity region impacts); ▪ Point, area, line, and volume sources; ▪ Plume rise as a function of downwind distance; ▪ Multiple point, area, line, or volume sources; ▪ Limited terrain adjustment; ▪ Long-term and short-term averaging modes; ▪ Rural or urban modes; ▪ Variable receptor grid density; ▪ Actual hourly meteorology data	▪ Can take up to 99 sources ▪ Computes concentration on 600 receptors in Cartesian on polar coordinate system ▪ Can take receptor elevation ▪ Requires source data, meteorological and receptor data as input.
PTMAX	▪ Screening model applicable for a single point source ▪ Computes maximum concentration and distance of maximum concentration occurrence as a function of wind speed and stability class	▪ Require source characteristics ▪ No met data required ▪ Used mainly for ambient air monitoring network design
PTDIS	▪ Screening model applicable for a single point source ▪ Computes maximum pollutant concentration and its occurrences for the prevailing meteorological conditions	▪ Require source characteristics ▪ Average met data (wind speed, temperature, stability class *etc*.) required ▪ Used mainly to see likely impact of a single source
MPTER	▪ Appropriate for point, area and line sources applicable for flat or rolling terrain ▪ Transport distance up to 50 km valid ▪ Computes for 1 hr to annual averaging periods ▪ Terrain adjustment is possible	▪ Can take 250 sources ▪ Computes concentration at 180 receptors up to 10 km ▪ Requires source data, meteorological data and receptor coordinates
CTDM PLUS (Complex Terrain Dispersion Model)	▪ Point source steady state model, can estimate hrly average concentration in isolated hills/ array of hills	▪ Can take maximum 40 Stacks and computes concentration at maximum 400 receptors ▪ Does not simulate calm met conditions ▪ Hill slopes are assumed not to exceed 15 degrees ▪ Requires sources, met and terrain characteristics and receptor details

Model	Application	Remarks
UAM (Urban Airshed Model)	▪ 3-D grid type numerical simulation model ▪ Computes O_3 concentration short term episodic conditions lasting for 1 or 2 days resulting from NOx and VOCs ▪ Appropriate for single urban area having significant O_3 problems	▪
RAM (Rural Airshed Model)	▪ Steady state Gaussian plume model for computing concentration of relatively stable pollutants for 1 hr to 1 day averaging time ▪ Application for point and area sources in rural and urban setting	▪ Suitable for flat terrains ▪ Transport distance less than 50 km.
CRESTER	▪ Applicable for single point source either in rural or urban setting ▪ Computes highest and second highest concentration for 1hr, 3hr, 24hr and annual averaging times ▪ Tabulates 50 highest concentration for entire year for each averaging times	▪ Can take up to 19 Stacks simultaneously at a common site. ▪ Unsuitable for cool and high velocity emissions ▪ Do not account for tall buildings or topographic features ▪ Computes concentration at 180 receptor, circular wing at five downwind ring distance 36 radials ▪ Require sources, and met data
OCD (Offshore and coastal Dispersion Model)	▪ It determines the impact of offshore emissions from point sources on the air quality of coastal regions ▪ It incorporates overwater plume transport and dispersion as well as changes that occur as the plume crosses the shore line ▪ Most suitable for overwater sources shore onshore receptors are below the lowest shore height	▪ Requires source emission data ▪ Require hrly met data at offshore and onshore locations like water surface temperature; overwater air temperature; relative humidity *etc*.
FDM (Fugitive Dust Model)	▪ Suitable for emissions from fugitive dust sources ▪ Source may be point, area or line (up to 121 source) ▪ Require particle size classification max. up to 20 sizes ▪ Computes concentrations for 1 hr, 3hr, 8hr, 24hr or annual average periods	▪ Require dust source particle sizes ▪ Source coordinates for area sources, source height and geographic details ▪ Can compute concentration at max. 1200 receptors ▪ Require met data (wind direction, speed, Temperature, mixing height and stability class) ▪ Model do not include buoyant point sources, hence no plume rise algorithm
RTDM (Rough Terrain Diffusion Model)	▪ Estimates GLC is complex/rough (or flat) terrain in the vicinity of one or more co-located point sources ▪ Transport distance max. up to 15 km to up to 50 km ▪ Computes for 1 to 24 hr. or annual ave5rage concentrations	▪ Can take up to 35 co-located point sources ▪ Require source data and hourly met data ▪ Computes concentration at maximum 400 receptors ▪ Suitable only for non reactive gases ▪ Do not include gravitational

Model	Application	Remarks
		effects or depletion mechanism such as rain/ wash out, dry deposition
CDM(Climatologically Dispersion Model)	▪ It is a climatologically steady state GPM for determining long term (seasonal or annual) ▪ Arithmetic average pollutant concentration at any ground level receptor in an urban area	▪ Suitable for point and area sources in urban region, flat terrain ▪ Valid for transport distance less than 50 km ▪ Long term averages: One month to one year or longer
PLUVUE-II (Plume Visibility Model)	▪ Applicable to assess visibility impairment due to pollutants emitted from well defined point sources ▪ It is used to calculate visual range reduction and atmospheric discoloration caused by plumes ▪ It predicts transport, atmospheric diffusion, chemical, conversion, optical effects, and surface deposition of point source emissions.	▪ Require source characteristics, met data and receptor coordinates & elevation ▪ Require atmospheric aerosols (back ground & emitted) characteristics, like density, particle size ▪ Require background pollutant concentration of SO_4, NO_3, NOx, NO_2, O_3, SO_2 and deposition velocities of SO_2, NO_2 and aerosols
MESO-PUFF II (Meso scale Puff Model)	▪ It is a Gaussian, Variable trajectory, puff superposition model designed to account fro spatial and temporal variations in transport, diffusion, chemical transformation and removal mechanism encountered on regional scale. ▪ Plume is modeled as a series of discrete puffs and each puff is transported independently ▪ Appropriate for point and area sources in urban areas ▪ Regional scale model.	▪ Can model five pollutants simultaneously (SO2, SO4, NOx, HNO3 and NO3) ▪ Require source characteristics ▪ Can take 20 point sources or 5 area source ▪ For area source – location, effective height, initial puff size, emission is required ▪ Computes pollutant concentration at max. 180 discrete receptors and 1600 (40 x 40) grided receptors ▪ Require hourly surface data including cloud cover and twice a day upper air data (pressure, temp, height, wind speed, direction) ▪ Do not include gravitational effects or depletion mechanism such as rain/ wash out, dry deposition

Table 2: Choice of Models for Impact Modeling: Noise Environment*

Model	Application
FHWA (Federal Highway Administration)	Noise Impact due to vehicular movement on highways

Dhwani	For predictions of impact due to group of noise sources in the industrial complex (multiple sound sources)
Hemispherical sound wave propagation Air Port	Fore predictive impact due to single noise source For predictive impact of traffic on airport and rail road

Table 3: Choice of Models for Impact Modeling: Land Environment*

Model	Application	Remarks
Digital Analysis Techniques	Provides land use / land cover distribution	
Ranking analysis for soil suitability criteria	Provides suitability criteria for developmental conversation activities	Various parameters viz. depth, texture, slope, erosion status, geomorphology, flooding hazards, GW potential, land use *etc*., are used.

Table 4: Choice of Models for Impact Modeling: Water Environment*

Model	Application	Remarks
QUAL-II E	Wind effect is insignificant, vertical dispersive effects insignificant applicable to streams Data required Deoxygenation coefficients, re-aeration coefficients for carbonaceous, nitrogenous and benthic substances, dissolved oxygen deficit	Steady state or dynamic model
	The model is found excellent to generate water quality parameters Photosynthetic and respiration rate of suspended and attached algae	
	Parameters measured up to 15 component can be simulated in any combination, e.g. ammonia, nitrite, nitrate, phosphorous, carbonaceous BOD, benthic oxygen demand, DO, coliforms, conservative substances and temperature	
DOSAG-3, USEPA: (1-D) RECEIV – II, USEPA	Water quality simulation model for streams & canal A general Water quality model	Steady-state
Explore –I, USEPA	A river basin water quality model	Dynamic, Simple hydrodynamics
HSPE, USEPA	Hydrologic simulation model	Dynamic, Simple hydrodynamics
RECEIVE-II, USEPA	A general dynamic planning model for water quality management	
Stanford watershed	This model simulates stream flows once historic	

Model	Application	Remarks
model	precipitation data are supplied The major components of the hydrologic cycle are modeled including interception, surface detention, overland inflow, groundwater, evapo-transpiration and routing of channel flows, temperature, TDS, DO, carbonaceous BOD coliforms, algae, zooplanktons, nitrite, nitrate, ammonia, phosphate and conservative substances can be simulated	
Hydrocomp model	Long-term meteorological and wastewater characterization data is used to simulate stream flows and stream water quality	Time dependant (Dynamic)
Stormwater Management model (SWMM)	Runoff is modeled from overland flow, through surface channels, and through sewer network Both combined and separate sewers can be modeled. This model also enables to simulate water quality effects to stormwater or combined sewer discharges. This model simulates runoff resulting from individual rainfall events.	Time Dependent
Battelle Reservoir model	Water body is divided into segments along the direction of the flow and each segment is divided into number of horizontal layers. The model is found to generate excellent simulation of temperature and good prediction of water quality parameters. The model simulates temperature, DO, total and benthic BOD, phytoplankton, zooplankton, organic and inorganic nitrogen, phosphorous, coliform bacteria, toxic substances and hydrodynamic conditions.	Two Dimensional multi-segment model
TIDEP (Turbulent diffusion temperature model reservoirs)	Horizontal temperature homogeneity Coefficient of vertical turbulent diffusion constant for charge of area with depth negligible coefficient of thermal exchange constant Data required wind speed, air temperature, air humidity, net incoming radiation, surface water temperature, heat exchange coefficients and vertical turbulent diffusion coefficients.	Steady state model
BIOLAKE	Model estimates potential fish harvest from a take	Steady state model
Estuary models/ estuarial Dynamic model	It is simulates tides, currents, and discharge in shallow, vertically mixed estuaries excited by ocean tides, hydrologic influx, and wind action Tides, currents in estuary are simulated	Dynamic model
Dynamic Water Quality Model	It simulates the mass transport of either conservative or non-conservative quality constituents utilizing information derived from the hydrodynamic model Bay-Delta model is the programme generally used. Up to 10 independent quality parameters of either conservative or non-conservative type plus the BOD-DO coupled relationship can be handled	Dynamic model

Model	Application	Remarks
HEC -2	To compute water surface profiles for stead7y, gradually: varying flow in both prismatic & non-prismatic channels	
SMS	Lake circulation, salt water intrusion, surface water profile simulation model	Surface water Modeling system Hydrodynamic model
RMA2	To compute flow velocities and water surface elevations	Hydrodynamic analysis model
RMA4	Solves advective-diffusion equations to model up to six non-interacting constituents	Constituent transport model
SED2D-WES	Model simulates transport of sediment	Sediment transport model
HIVEL2D	Model supports subcritical and supercritical flow analysis	A 2-dimensional hydrodynamic model
MIKE-II, DHI	Model supports, simulations of flows, water quality, and sediment transport in estuaries, rives, irrigation systems, channels & other water bodies	Professional Engineering software package

Table 5: Choice of Models for Impact Modeling: Biological Environment*

Name	Relevance	Applications	Remarks
Flora			
Sample plot methods	Density and relative density Density and relative dominance	Average number of individuals species per unit area Relative degree to which a species predominates a community by its sheer numbers, size bulk or biomass	The quadrant sampling technique is applicable in all types of plant communities and for the study of submerged, sessile (attached at the base) or sedentary plants
	Frequency and relative frequency importance value	Plant dispersion over an area or within a community	Commonly accepted plot size: 0.1 m^2- mosses, lichens & other mat-like plants
		Average of relative density, relative dominance and relative frequency	0.1 m^2- herbaceous vegetation including grasses
			10.20 m^2 – for shrubs and saplings up to 3m tall, and
			100 m^2 – for tree communities
Transects & line intercepts methods	Cover	Ratio of total amount of line intercepted by each species and total length of the line intercept given its cover	This methods allows for rapid assessment of vegetation transition zones, and requires minimum time or equipment of establish
	Relative	It is the ratio of total	Two or more vegetation strata can be

Name	Relevance	Applications	Remarks
	dominance	individuals of a species and total individuals of all species	sampled simultaneously
Plot-less sampling methods	Mean point plant Mean area per plant	Mean point – plant distance Mean area per plant	Vegetation measurements are determined from points rather than being determined in an area with boundaries
	Density and relative density		Method is used in grass-land and open shrub and tree communities
	Dominance and relative dominance		It allows more rapid and extensive sampling than the plot method
	Importance value		Point- quarter method is commonly used in woods and forests.
Fauna			
Species list methods	Animal species list	List of animal communities observed directly	Animal species lists present common and scientific names of the species involved so that the faunal resources of the area are catalogued
Direct Contact Methods	Animal species list	List of animals communities observed directly	This method involves collection, study and release of animals
Count indices methods (Roadside and aerial count methods)	Drive counts Temporal counts	Observation of animals by driving them past trained observers	Count indices provide estimates of animal populations and are obtained from signs, calls or trailside counts or roadside counts
	Call counts	Count of all animals passing a fixed point during some stated interval of time	These estimates, through they do not provide absolute population numbers, Provide an index of the various species in an area
			Such indices allow comparisons through the seasons or between sites or habitats
Removal methods	Population size	Number of species captured	Removal methods are used to obtain population estimates of small mammals, such as, rodents through baited snap traps
Market capture methods	Population size estimate (M)	Number of species originally marked (T) Number of marked animals recaptured (t) and total number of animals captured during census (n) N = nT/t	It involves capturing a portion of the population and at some later date sampling the ratio of marked to total animals caught in the population

Table 6: Choice of Models for Impact Predictions: Socio-economic Environment*

Relevance		
Name	**Application**	**Remarks**
Extrapolative Methods	A prediction is made that is consistent with past and present socio-economic data, e.g. a prediction based on the linear extrapolation of current trends	
Intuitive Forecasting (Delphi techniques)	Delphi technique is used to determine environmental priorities and also to make intuitive predictions through the process of achieving group consensus	Conjecture Brainstorming Heuristic programming Delphi consensus
Trend extrapolation and correlation	Predictions may be obtained by extrapolating present trends Not an accurate method of making socio-economic forecasts, because a time series cannot be interpreted or extrapolated very far into the future with out some knowledge of the underlying physical, biological, and social factors	Trend breakthrough precursor events correlation and regression
Metaphors and analogies	The experience gained else where is used to predict the socio-economic impacts	Growth historical simulation commonsense forecasts
Scenarios	Scenarios are common-sense forecasts of data. Each scenario is logically constructed on model of a potential future for which the degrees of "confidence" as to progression and outcome remain undefined	Common-sense
Dynamic modeling (Input- Out model)	Model predicts net economic gain to the society after considering all inputs required for conversion of raw materials along with cost of finished product	
Normative Methods	Desired socio-economic goals are specified and an attempt is made to project the social environment backward in time to the present to examine whether existing or planned resources and environmental programmes are adequate to meet the goals	Morphological analysis technology scanning contextual mapping - functional array - graphic method Mission networks and functional arrays decision trees & relevance trees matrix methods scenarios

*** NOTE:** (i) If a project proponent prefer to use any model other than listed, can do so, with prior concurrence of concerned appraisal committee. (ii) Project-specific proposed prediction tools need to be identified by the project proponent and shall be incorporated in the draft ToR to be submitted to the Authority for the consideration and approval by the concerned EAC/SEAC.

ANNEXURE XIV

Form through which the State Governments/Administration of the Union Territories Submit Nominations for SEIAA and SEAC for the Consideration and Notification by the Central Government

Form for Nomination of a professional/expert as Chairperson / Member / Secretary of the SEIAA / EAC / SEAC						
1	Name (in block letters)					
2	Address for communication					
3	Age & Date of Birth (Shall be less than 67 years for the members and 72 years for the Chairman)					
4	Area of Expertise (As per Appendix VI)					
5	Professional Qualifications (As per Appendix VI)	Qualification(s)		University	Year of passing	Percentage of marks
6	Work experience (High light relevant experience as per Appendix VI)	Position	Years of association			Nature of work. If required, attach separate sheets
			From	to	Period in years	
7	Present position and nature of job	Serving Central / State Government Office?			Yes/No	
		Engaged in industry or their associations?			Yes/No	
		Associated with environmental activism?			Yes/No	
		If no is the answer for above three, please specify the present position and name of the organization				
8	Whether experienced in the process of prior environmental clearance?	Yes/No. If yes, please specify the experience in a separate sheet (Please restrict to 500 words)				
9	Whether any out-standing expertise has been acquired?	Yes/ No If yes, please provide details in a separate sheet (Please restrict to 500 words).				
10	Any other relevant information?	May like to attach separate sheets (Research projects, consultancy projects, publications, memberships in associations, trainings undergone, international exposure cum experience etc.)				

The Government of……is pleased to forward the Nomination of Dr./Sh. ……..…. for the position of Chairperson / Member / Secretary of the SEIAA / SEAC / EAC to the Ministry of Environment & Forests, the Government of India for the Notification.

(Authorized Signature with Seal)

ANNEXURE XV
Composition of EAC/SEAC

Composition of the EAC/SEAC

The Members of the EAC shall be Experts with the requisite expertise and experience in the following fields /disciplines. In the event that persons fulfilling the criteria of "Experts" are not available, Professionals in the same field with sufficient experience may be considered:

- Environment Quality Experts: Experts in measurement/monitoring, analysis and interpretation of data in relation to environmental quality
- Sectoral Experts in Project Management: Experts in Project Management or Management of Process/Operations/Facilities in the relevant sectors.
- Environmental Impact Assessment Process Experts: Experts in conducting and carrying out Environmental Impact Assessments (EIAs) and preparation of Environmental Management Plans (EMPs) and other Management plans and who have wide expertise and knowledge of predictive techniques and tools used in the EIA process
- Risk Assessment Experts
- Life Science Experts in floral and faunal management
- Forestry and Wildlife Experts
- Environmental Economics Expert with experience in project appraisal

ANNEXURE XVI

Best Practices available and reference

Best Practices available and reference

Suggested practices to minimize environmental impacts of landfills:

- Biogas produced by decomposing organic waste can be used in electricity generation, to prevent release of potent greenhouse gases into the atmosphere
- Waste is covered at the end of each day, minimising the escape of litter and odour into the environment
- Water is sprayed to suppress dust
- Thick clay layers and liners are placed in each cell to prevent leachate from reaching underground water systems
- Waste is compacted to allow for a maximum lifespan of landfill

Incineration Technology

Key criterion for incineration technology:

- The technology should be based on the mass burning principle. Furthermore, the supplier must have numerous reference plants in successful operation for a number of years.
- The furnace must be designed for stable and continuous operation and complete burnout of the waste and flue gases (CO<50 mg/Nm3, TOC<10 mg/Nm3).
- The flue gases from the furnace must be cooled to 200°C or lower before flue gas treatment.
- The flue gas cleaning equipment must be at least a two-field ESP (basic emission control, dust<30 mg/Nm3).
- A controlled landfill must be available for residue disposal. Full leachate control must be exercised at the landfill.
- Municipal solid waste incineration plants should be in land-use zones dedicated to medium or heavy industry.
- Stack height should not be less than 30 meters
- Stack height requirement based on sulfur dioxide emissions by using the equation – stack height =14 (Q) 0.3 [where, Q is the emission rate of SO2 in kg/hr]
- By using simple Gaussian plume model to maintain ambient air quality requirements for all concerned parameters in the receiving environment

Good combustion practices:

- To control emissions by ensuring that the temperature in the combustion chamber and the time MSW remains in the combustion chamber are kept at optimal levels.
- Newer incinerators are equipped with computer control systems to maintain a high degree of consistency in plant operations
- Air pollution control equipment must also be carefully maintained to prevent the release of contaminants.

Incinerator Ash:

Risks:
MSW incineration generates ash, representing about 10% by volume and 25-35% by weight of the waste incinerated. Incinerator ash can contain concentrations of heavy metals such as lead, cadmium, mercury, arsenic, copper, and zinc, which originate from plastics, colored printing inks, batteries, certain rubber products, and hazardous waste from households and small industrial generators. Organic compounds such as dioxins and furans have also been detected in incinerator ash.

The principal environmental concern of the public regarding incinerator ash is that when ash is disposed of in a landfill, the metals and organic compounds can leach (i.e., dissolve and move from the ash through liquids in the landfill) and migrate into ground water or nearby surface water. In addition to possibly contaminating water supplies, incinerator ash could also affect human health through direct inhalation or ingestion of airborne or settled ash.

***Techniques to cope with incinerator ash*:**

- Incinerator ash is usually disposed of in an MSW landfill (ideally in a special section) or an ash-only landfill known as an ash monofill. Ash monofills are specially designed to reduce the ability of heavy metals to migrate from the ash into the environment.
- Monofills can be co-located with MSW incinerators or existing landfills to reduce transportation distances and siting difficulties

- Ash can be stabilized and solidified by encasing in concrete prior to disposal, thereby significantly reducing the potential for the contaminant to migrate.

Sources:
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